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LIGHTWEIGHT TOWED HOWITZER DEMONSTRATOR PHASE 1 AND
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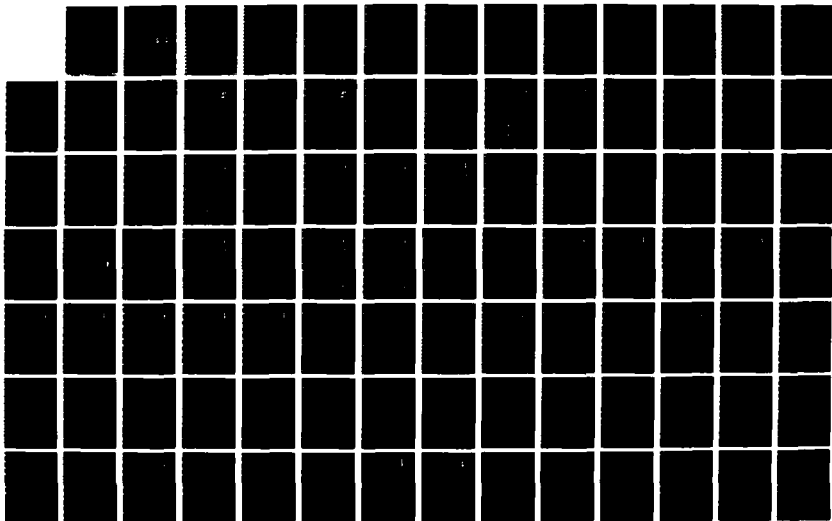
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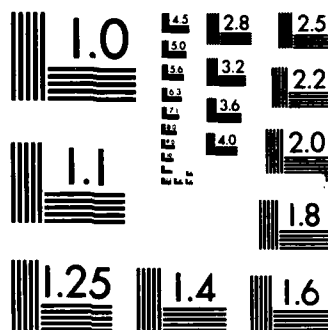
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Lightweight Towed Howitzer Demonstrator

Final Report

Volume B

Hydraulic Component Design by York

April 1987

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Contract Number DAAA21-86-C-0047

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Northern Ordnance Division
4800 East River Road
Minneapolis, Minnesota 55421

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The LTHD (Lightweight Towed Howitzer Demonstrator) was to be a 9,000 lb equivalent to the M198, transportable via Blackhawk helicopter, with reduced emplacement time using fewer personnel. The FMC design achieved weight reduction via a mortar-like configuration, composites structure, and hydraulic actuators. Recovery of power from the recoil system, in turn, facilitated crew reduction via hydraulic emplacement, four-way joystick tube lay, and power ramming. FMC completed Concept Development (Ph I) and two-thirds of Detailed Design (Ph II) prior to funds running out. <i>Keywords:</i>		

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DESCRIPTION: FINAL STATUS REPORT

STATUS - PER FMC:

The hydraulic component designs are well integrated with system design. The performance requirements appear feasible. The total weight budget (established by early FMC estimates) appears realistic.

Some preliminary discussions with metallurgists familiar with titanium suggest it may be feasible as a hydraulic cylinder and rod material which could, in turn, facilitate a further weight reduction. Other discussions regarding AlSiCp also suggested this material suitable as a hydraulic cylinder material. Neither approach was pursued, but both suggest additional weight reduction is feasible.

The only known problem remaining is potential overloading of the walking beam actuators due to road input (see E/260, E/270, and C/270).

The component paragraphs within this section are repeated within the component sections for clarity.

AUTHOR: Jeff Ireland/Bart Anderson

March 13, 1987

FINAL REPORT

PAC LIGHTWEIGHT TOWED
HOWITZER DEMONSTRATOR
Hydraulic Components

P. O. P68622-84-LWHD

York Industries, Inc.

1750 Toronita Street

York, PA 17402

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(81616)

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1.0 Introduction and Summary

This is the final status summary report for the design of the LWTHD hydraulic components assigned to York Industries Inc. as of March 13, 1987. The design effort had reached the final stage with part detailing begun. The design concept phase had been completed on all components except the Walking Beam Actuators. Per FMC direction, one 9 track magnetic tape copy of the CAD drawing files and a set of B-size reproducible drawings is enclosed. Table 1 lists those drawings which are being submitted. A comparison of estimated weight to the allotted weight budget is presented by Table 2. The performance analysis of the elevation subsystem was begun, but suspended early in the program. ~~Appendix~~ presents the available results. SECTION E/180

2.0 Overview:

The Aerospace Division of York Industries Incorporated (YII) was under contract to FMC, Northern Ordnance Division, to provide a number of hydraulic components for the Lightweight Towed Howitzer Demonstrator (LWTHD) program. This effort consisted of the design of each component, an analysis of the performance and structural adequacy and the delivery of an assembly drawing at the completion of program Phase 2. Fabrication and delivery of hardware was anticipated in a later Phase 3 follow-on.

State-of-the-art technology was to be employed in this effort. The equilibration and traverse actuators employed the YII patented BearLoc position locking actuator for obtaining and holding azimuth and elevation aiming. Kevlar wrapping of actuators and accumulators was used to minimize weight and to provide resistance to fragmentation, both of which had been qualified on earlier programs. The materials of construction, corrosion protection and thin wall cylinder fabrication techniques had all been demonstrated on prior programs, therefore, the bulk of the technology demonstration effort in the LWTHD program could be directed to the non-hydraulic aspects.

3.0 Component Design Status:

The design status for each component is described below. Those components whose part numbers are grouped utilize a single design with only minor mounting differences. The design effort consists of the following sub-phases which were used for internal YII tracking of progress against cost, schedule and weight budgets. The "Concept design" sub-phase defines the basic configuration of the component and matches it to the required space and performance envelope. The "Initial Assembly" sub-phase refines the concept drawing by adding the load attachments and ports, and by conducting the first analysis directed at reducing weight. The "Final Assembly" sub-phase consists of assigning part numbers to the detail parts, conducting a detail level stress analysis of critical regions and an independent evaluation of piece part fabricability. The "Detailing" sub-phase generates drawings for each of the piece parts contained in the component assembly.

P/N T-1257 5712/B - ACTUATOR, EQUILIBRATION - RIGHT SIDE
P/N T-1257 5713/B - ACTUATOR, EQUILIBRATION - LEFT SIDE

The assembly drawing was nearing completion and the stress analysis was begun. This component had been identified by YII as a long lead item and the design was scheduled for fabrication process review and assembly tooling design. This component was well within its weight budget after Kevlar wrapping of the actuator cylinder was incorporated.

P/N T-1257 5714/B - ACTUATOR, TRAVERSE

The concept drawing is complete but the the stroke must be changed to the requirements of the March 6 coordination meeting. The projected weight estimate is over the allotted target weight due to the increase in stroke, thus another weight reduction pass would have been required.

P/N T-1257 5716/C - ACTUATOR, ELEVATION
P/N T-1257 5717/A - ACTUATOR, ELEVATION - LEFT SIDE (deleted)

A single actuator, attached to the center of the slide, was substituted for the original one on each side and the stroke was lengthened. The concept drawing for the revised stroke was completed and was in review for fabrication evaluation. The projected weight of this actuator meets its weight budget, however, further reduction was planned to allow for the weight growth in the Counter-recoil Accumulators as discussed later. Tailoring of cushioning at end of stroke is planned whenever the acceleration requirements become defined.

P/N T-1257 5718/B - ACCUMULATOR, COUNTER-RECOIL - RIGHT SIDE
P/N T-1257 5719/B - ACCUMULATOR, COUNTER-RECOIL - LEFT SIDE

The concept drawing for these accumulators is approximately 90 % complete, however, the increase in volume from 1600 cubic inches to 2400 inches drives its estimated weight above the target weight by a significant amount. In the interest of weight reduction, it is recommended that the factor of safety on maximum operating pressure for proof pressure be reduced from the standard value of 2.0 to a value of 1.5 and that the burst factor be reduced from 4.1 to 3.0 on the cylindrical section only. Design factors of safety for the end caps and threaded joints remain at the standard level of 4.0. FMC approval was obtained at the March 6, 1987 coordination meeting.

P/N T-1257 5720/B - ACCUMULATOR UNIT, FEED & EQUILIBRATION

The newly defined port manifold was being added to the concept drawing of the Accumulator Unit at the time of contract termination. The mounting techniques for both accumulators had been defined and coordinated with FMC. The front slide mount carries both axial and radial loads. Slip joints are used at the mid-slide mount so that expansion of the accumulators does not load the slide, therefore only radial loads are carried. The piston position indicators are located near the mid-slide mount. The YII request for an evaluation of readability of position indicators as shown by the concept drawing was still pending.

P/N T-1257 5720-1/B - ACCUMULATOR, EQUILIBRATION

P/N T-1257 5720-2/A - ACCUMULATOR, EQUILIBRATION (deleted)

The concept drawing of the equilibration accumulator had been completed and the assembly drawing was being revised to change the length of the accumulator to facilitate its mounting to the slide. This component meets its weight budget and was in fabricability review. The length of the cylinder of this accumulator was set by the need to match the length of the Feed Accumulator as a means to minimize overall system weight, however, this length forced this component into the list of long lead items being prepared at the time of contract termination.

P/N T-1257 5720-3/B - ACCUMULATOR, FEED

The concept drawing for the feed accumulator is complete and the assembly drawing was being revised to change the length of the accumulator to facilitate its mounting to the slide. This component meets its weight budget and was in fabricability review. The length of the cylinder of this accumulator was set by the need to match the length of the Equilibration Accumulator as a means to minimize overall system weight.

P/N T-1257 5721/B - ACTUATOR, WALKING BEAM - LH FRONT

P/N T-1257 5723/B - ACTUATOR, WALKING BEAM - RH FRONT

The concept drawing on this component had been completed and the assembly drawing was being revised to incorporate 2 inches of free travel in the transit mode. Several approaches to obtain free travel were being evaluated which would have been added to the assembly drawing when complete. The design provisions for free travel were being evaluated on the rear actuators and would have been added to these actuators when complete. An extended stroke pin lock was incorporated into the actuator. This lock is actuated by hydraulic pressure and provides a flag of lock/unlock status. The assembly drawing was being revised to mount the FMC specified control valve directly on the actuator. This unit, as revised, exceeds its weight budget by 20% and required further design effort directed at weight reduction.

P/N T-1257 5722/B - ACTUATOR, WALKING BEAM - LH REAR
P/N T-1257 5724/B - ACTUATOR, WALKING BEAM - RH REAR

The concept drawing on this component had been completed and the assembly drawing was being revised to incorporate 2 inches of free travel in the transit mode. Several approaches to obtain free travel were being evaluated which would have been added to the assembly drawing when complete. The extended stroke pin lock was also incorporated into the actuator. The assembly drawing was being revised to mount the FMC specified control valve directly on the actuator. This unit, as revised, exceeds its weight budget by 20% and required further design effort directed at weight reduction.

P/N T-1257 5725/A - ACTUATOR, BREECH

The concept drawing for the Breech actuator had been completed and the assembly drawing was being revised to incorporate a check valve and FMC specified port locations. The pilot operated check valve provides an extended stroke position lock when hydraulic pressure is removed from the unit. This unit meets its weight budget and no further weight reduction is required.

P/N T-1257 5726/A - ACTUATOR, AUTO-PRIMER

The concept drawing on this actuator was approximately 80% complete. Design provisions for extensive flexing of its mount and adjacent components were being evaluated. The weight of this unit exceeds its budget due to the extensive manifold incorporated into its requirements. Since, there is little expectation of being able to reduce its weight to the budget level, it was recommended that its weight budget be appropriately revised.

P/N T-1257 5727/A - ACTUATOR, LANYARD

The concept drawing on this actuator was approximately 90% complete. The first review of the design was in progress at the time of contract termination. Although the weight analysis of this actuator had not been updated for the then current design, its estimated weight was near its weight budget and no further weight reduction was anticipated.

P/N T-1257 5728/A - ACTUATOR, LOAD POSITION

The concept drawing for the load position actuator was complete and the design was in process of a fabricability review at the time of contract termination. Although the weight analysis of this actuator had not been updated for the then current design, its estimated weight was near its weight budget and no further weight reduction was anticipated.

P/N T-1257 5729/A - ACTUATOR, INERTIAL RAMMER

The concept drawing on this actuator was completed and the assembly drawing begun. An internal design review of fabricability and assembly potential problems was in progress. The design of this actuator permits extensive flexing in its mounts and possible problems were being evaluated. The weight of this unit exceeds its budget, therefore, further weight reduction effort is anticipated.

4.0 Performance Analysis:

An analysis of the static and dynamic performance of the hydraulic systems for elevation and traverse was planned for this program, but was suspended midway through the program so that available resources could be applied to the basis design of the components. Initial results are provided in ~~APPENDIX~~ for the early configuration. No effort was expended and therefore no results are available which evaluate the fluid inertia effects incurred by operation of the hydraulic subsystems.

SECTION E/180

Final Status Report
FMC Hydraulic Component Design
P.O. P68622-84-LWHD

March 13, 1987
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Table 1 - Drawing Submittal Summary

FMC Part Number	Nomenclature	YII Drawing Number	Rev	P A R T S	B R O K E N	F U L L
T-1258 5712/B	Actuator, Equilibration RH	01-60356	A	1	2	-
T-1258 5713/B	Actuator, Equilibration RH		B	1	2	3
			C	1	-	2
	Intensifier, Pressure	19-60004	A	-	-	2
T-1258 5714/B	Actuator, Traverse	01-60355	-	1	-	-
			A	1	-	-
			B	1	-	-
T-1258 5716/C	Actuator, Elevation	02-60156	-	1	-	3
			A	1	-	3
			B	1	2	3
			C	1	2	3
T-1258 5718/B	Accumulator, C.recoil - RH	08-60149	-	1	2	3
T-1258 5719/B	Accumulator, C.recoil - LH		A	-	-	-
			B	1	2	3
			C	-	-	3
			D	-	-	3
			E	-	-	-
			F	-	-	-
			G	1	2	3
T-1258 5720/B	Accumulator Unit, Feed & Equilibration	08-60999	A	1	-	-
			B	1	-	-
T-1258 5720-1/B	Accumulator, Equilibration	08-60156	A	-	2	3
			B	1	2	3
			C	1	2	-
			D	1	2	3
	Cylinder	08-40565	-	-	-	1
	Cylinder, Machine	08-40564	-	-	-	1
	Piston	08-40566	-	-	-	1
	End Cap, Gas	08-40569	-	-	-	1
	End Cap, Fluid	08-40570	-	-	-	1
	Position Indicator	08-40577	-	-	-	1
	Housing, Indicator	08-40572	-	-	-	1
	Bushing, Indicator	08-40573	-	-	-	1
	Wheel, Indicator	08-40574	-	-	-	1
	Shaft, Indicator	08-40575	-	-	-	1
	Indicator	08-40576	-	-	-	1

Final Status Report
FMC Hydraulic Component Design
P.O. P68622-84-LWHD

March 13, 1987
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Table 1 - Drawing Submittal Summary

FMC Part Number	Nomenclature	YII Drawing Number	Rev	P A R T S	B R O K E N	F U L L
T-1258 5720-3/B	Accumulator, Feed	08-60150	A B C D	- - - 1	2 2 - 2	- - 3 -
T-1258 5721/B T-1258 5723/B	Actuator, Walking, LH, Front Actuator, Walking, RH, Front	02-60154	- A B C	- 1 1 -	- - - -	2 2 2 2
T-1258 5722/B T-1258 5724/B	Actuator, Walking, LH, Rear Actuator, Walking, RH, Rear	02-60155	A B C	- - 1	- - -	- 2 2
T-1258 5725/A	Actuator, Breech	02-60160	- A B	- - -	- - -	2 2 2
T-1258 5726/A	Actuator, Auto-primer	02-60158	- A B	- - -	- - -	- 1 1
T-1258 5727/A	Actuator, Lanyard	02-60159	- A	- -	- -	1 1
T-1258 5728/A	Actuator, Load Position	02-60161	- A	- -	2 2	3 3
T-1258 5729/A	Actuator, Inertial Rammer	02-60151	- A B C	- - - -	- - - 2	2 2 2 3

Final Status Report
FMC Hydraulic Component Design
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March 13, 1987
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Table 2 - Hydraulic Component Weight Summary

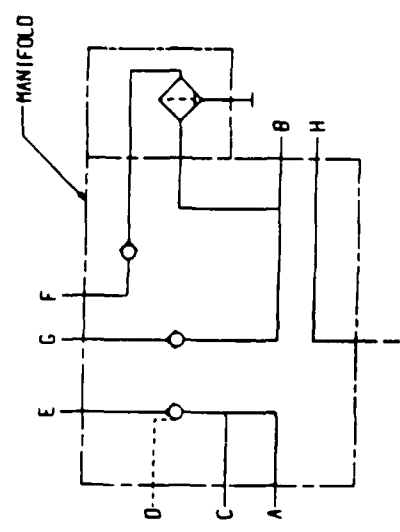
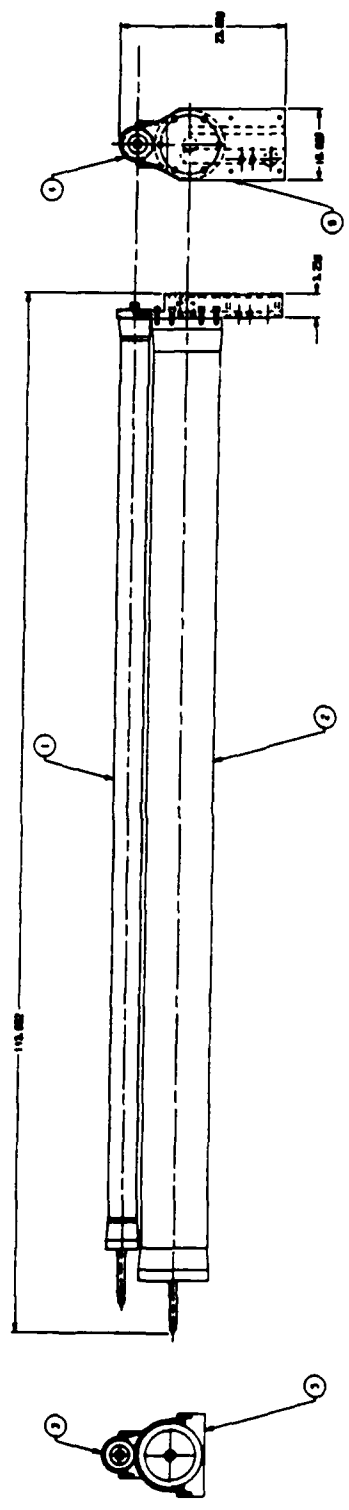
FMC Part Number	Nomenclature	YII Part Number	Budget	Estimate
T-1258 5712/B	Actuator, Equilibration RH	01-60356	135.00	110.14
T-1258 5713/B	Actuator, Equilibration RH		135.00	110.14
T-1258 5714/B	Actuator, Traverse	01-60355	110.00	118.35
T-1258 5716/C	Actuator, Elevation	02-60156	44.00	36.87
T-1258 5718/B	Accumulator, C.recoil - RH	08-60149	140.00	146.59
T-1258 5719/B	Accumulator, C.recoil - LH		140.00	146.59
T-1258 5720/B	Accum. Unit, Feed & Equil	08-60999	36.00	43.18
T-1258 5720-1/B	Accumulator, Equilibration	08-60156	60.00	60.05
T-1258 5720-3/B	Accumulator, Feed	08-60150	70.00	68.57
T-1258 5721/B	Actuator, Walking, LH, Front	02-60154	22.00	27.87
T-1258 5723/B	Actuator, Walking, RH, Front		22.00	27.87
T-1258 5722/B	Actuator, Walking, LH, Rear	02-60155	22.00	26.34
T-1258 5724/B	Actuator, Walking, RH, Rear		22.00	26.34
T-1258 5725/A	Actuator, Breech	02-60160	5.00	4.00
T-1258 5726/A	Actuator, Auto-primer	02-60158	2.50	5.16
T-1258 5727/A	Actuator, Lanyard	02-60159	1.00	4.38
T-1258 5728/A	Actuator, Load Position	02-60161	35.00	33.78
T-1258 5729/A	Actuator, Inertial Rammer	02-60151	30.00	38.80
			1031.50	1035.02

DESCRIPTION: ACCUMULATOR UNIT ASSEMBLY

STATUS - PER YORK:

The newly defined port manifold was being added to the concept drawing of the Accumulator Unit at the time of contract termination. The mounting techniques for both accumulators had been defined and coordinated with FMC. The front slide mount carries both axial and radial loads. Slip joints are used at the mid-slide mount so that expansion of the accumulators does not load the slide; therefore, only radial loads are carried. The piston position indicators are located near the mid-slide mount. The YII request for an evaluation of readability of position indicators as shown by the concept drawing was still pending.

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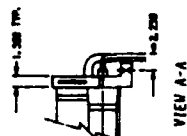
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										YORK INDUSTRIES INC.										ACCUMULATOR UNIT, FEED & EQUILIBRATION 1-1230 3728/9										D 81616 08 60999 B									
										YORK INDUSTRIES INC.										ACCUMULATOR UNIT, FEED & EQUILIBRATION 1-1230 3728/9										D 81616 08 60999 B									
										YORK INDUSTRIES INC.										ACCUMULATOR UNIT, FEED & EQUILIBRATION 1-1230 3728/9										D 81616 08 60999 B									
										YORK INDUSTRIES INC.										ACCUMULATOR UNIT, FEED & EQUILIBRATION 1-1230 3728/9										D 81616 08 60999 B									
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										YORK INDUSTRIES INC.										ACCUMULATOR UNIT, FEED & EQUILIBRATION 1-1230 3728/9										D 81616 08 60999 B									
										YORK INDUSTRIES INC.										ACCUMULATOR UNIT, FEED & EQUILIBRATION 1-1230 3728/9										D 81616 08 60999 B									
										YORK INDUSTRIES INC.										ACCUMULATOR UNIT, FEED & EQUILIBRATION 1-12																			

DESCRIPTION: ACCUMULATOR UNIT ASSEMBLY (Obsolete)

STATUS - PER FMC:

Port manifold addition (E/110) obsoleted this design. This manifold was added to facilitate circuit integration while improving reliability and durability.

AUTHOR: Jeff Ireland/Bart Anderson

[illegible][illegible]

DESCRIPTION: EQUILIBRATION ACCUMULATOR

STATUS - PER YORK:

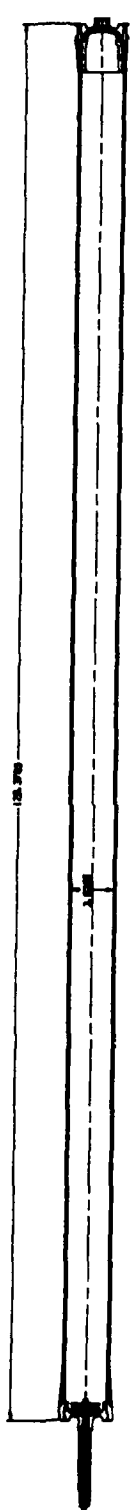
The concept drawing of the equilibration accumulator had been completed and the assembly drawing was being revised to change the length of the accumulator to facilitate its mounting to the slide. This component meets its weight budget and was in fabricability review. The length of the cylinder of this accumulator was set by the need to match the length of the Feed Accumulator as a means to minimize overall system weight, however, this length forced this component into the list of long lead items being prepared at the time of contract termination.

NOTES:

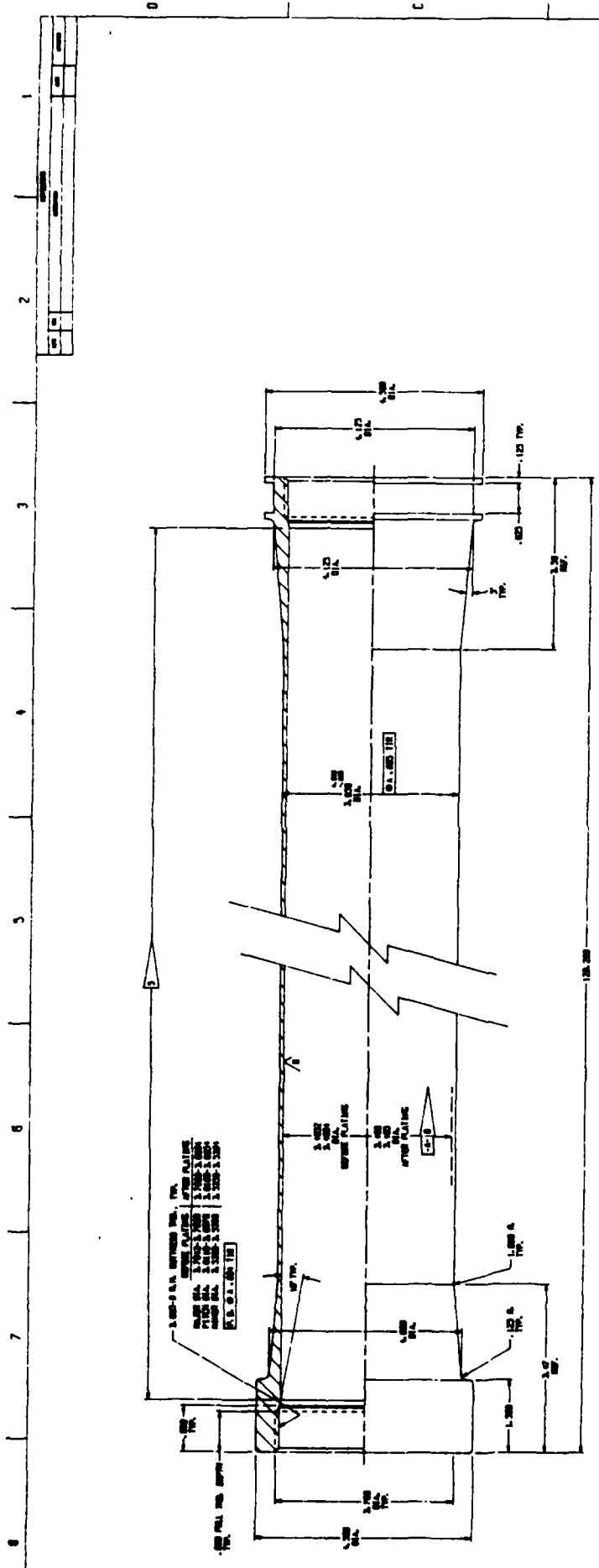
1. OPERATING MEDIA: HYDRAULIC FLUID PER MIL-H-8132, NITROGEN PER MIL-H-411.
2. PRESSURES: GAS CHARGE : 2700 PSIG
HYDRAULIC : 2700 PSIG
MAX. OPERATING : 2700 PSIG
PROOF : 3600 PSIG
BURST : 13500 PSIG
3. TEMPERATURE: NON-OPERATING : MINUS 70 TO 100°F
OPERATING : MINUS 25 TO 100°F
4. VOLUME: GAS - 1200 CU. IN. MIN.
5. FLOWRATE: 20 GPM

QTY	ITEM NO.	DESCRIPTION	UNIT	QTY	ITEM NO.	DESCRIPTION	UNIT
1	18	POSITION INDICATOR ASST		1	18	POSITION INDICATOR ASST	
		OR 4037-7				OR 4037-7	
		INDICATOR				INDICATOR	
		OR 4037-7				OR 4037-7	
		SWT				SWT	
		OR 4037-7				OR 4037-7	
		SEAL RING				SEAL RING	
		OR 4037-7				OR 4037-7	
		WASHER, THIN				WASHER, THIN	
		OR 4037-7				OR 4037-7	
		WASHER				WASHER	
		OR 4037-7				OR 4037-7	
		BUSHING				BUSHING	
		OR 4037-7				OR 4037-7	
		HOUSING, INDICATOR				HOUSING, INDICATOR	
		OR 4037-7				OR 4037-7	
		PISTON				PISTON	
		OR 4037-7				OR 4037-7	
		CABLE				CABLE	
		OR 4037-7				OR 4037-7	
		SPRING				SPRING	
		OR 4037-7				OR 4037-7	
		FITTING, GAS PORT				FITTING, GAS PORT	
		OR 4037-7				OR 4037-7	
		SEAL RING				SEAL RING	
		OR 4037-7				OR 4037-7	
		SEAL RING				SEAL RING	
		OR 4037-7				OR 4037-7	
		BACK-UP RING				BACK-UP RING	
		OR 4037-7				OR 4037-7	
		O-RING				O-RING	
		OR 4037-7				OR 4037-7	
		END CAP, OIL				END CAP, OIL	
		OR 4037-7				OR 4037-7	
		END CAP, GAS				END CAP, GAS	
		OR 4037-7				OR 4037-7	
		PISTON ASST				PISTON ASST	
		OR 4037-7				OR 4037-7	
		CABLE ATTACH				CABLE ATTACH	
		OR 4037-7				OR 4037-7	
		PISTON, MACHINE				PISTON, MACHINE	
		OR 4037-7				OR 4037-7	
		CYLINDER ASST				CYLINDER ASST	
		OR 4037-7				OR 4037-7	
		CYLINDER				CYLINDER	
		OR 4037-7				OR 4037-7	
		HYDRAULIC ACCUM., EQUILIBRATION, 1-1258 5720-1/C				HYDRAULIC ACCUM., EQUILIBRATION, 1-1258 5720-1/C	

YORK INDUSTRIES INC.	
HYDRAULIC ACCUMULATOR, EQUILIBRATION	
T-1258 5720-1/C	
C 81616	08 60156
08 60156	08 60156

0	1	2	3	4	5	6	7	8
								9
<div style="display: flex; justify-content: space-between;"> <div> <p>0</p> <p>1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p> </div> <div> <p>9</p> <p>0</p> <p>1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p> </div> </div>								<p>0</p> <p>1</p> <p>2</p> <p>3</p> <p>4</p> <p>5</p> <p>6</p> <p>7</p> <p>8</p>

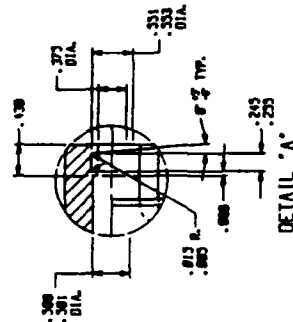
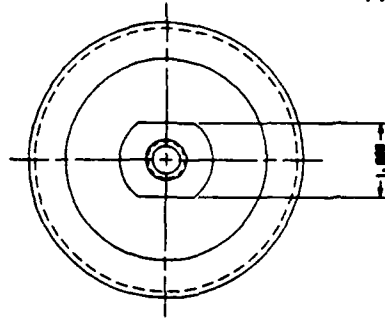
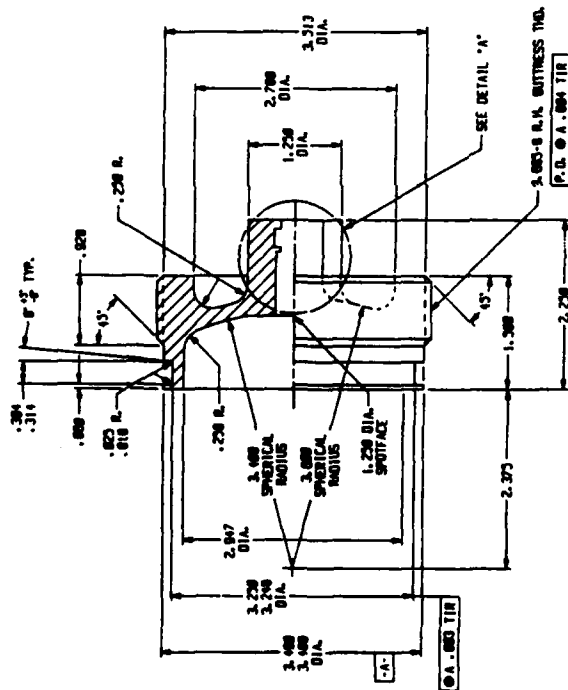
YORK INDUSTRIES INC.		ACCUMULATOR, EQUILIBRATION	
1-1250 3/20-001/0		1-1250 3/20-001/0	
D 81616		08 60156	
1		2	
3		4	
5		6	
7		8	
9		0	



NOTES:

1. MATERIAL: STEEL, 1/2" THICK, 1/2" DIA.
2. ALL DIMENSIONS ARE IN INCHES, UNLESS OTHERWISE SPECIFIED.
3. ALL DIMENSIONS ARE TO BE TAKEN FROM THE CENTERLINE OF THE CYLINDER.
4. ALL DIMENSIONS ARE TO BE TAKEN FROM THE CENTERLINE OF THE CYLINDER.
5. ALL DIMENSIONS ARE TO BE TAKEN FROM THE CENTERLINE OF THE CYLINDER.
6. ALL DIMENSIONS ARE TO BE TAKEN FROM THE CENTERLINE OF THE CYLINDER.
7. ALL DIMENSIONS ARE TO BE TAKEN FROM THE CENTERLINE OF THE CYLINDER.
8. ALL DIMENSIONS ARE TO BE TAKEN FROM THE CENTERLINE OF THE CYLINDER.
9. ALL DIMENSIONS ARE TO BE TAKEN FROM THE CENTERLINE OF THE CYLINDER.
10. ALL DIMENSIONS ARE TO BE TAKEN FROM THE CENTERLINE OF THE CYLINDER.

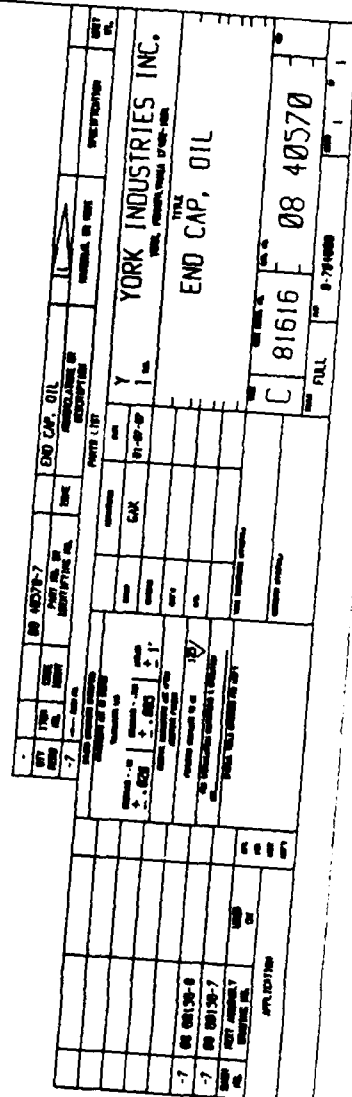
YORK INDUSTRIES INC.	
CYLINDER	
0 81616	08 40564
1	



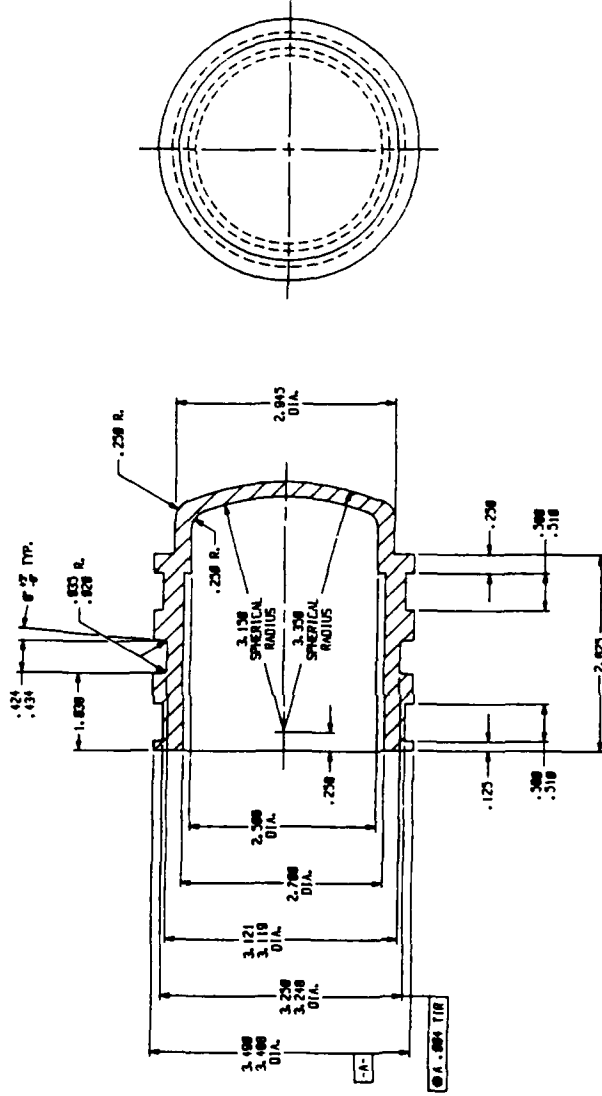
1 MATERIAL: CRCS STEEL, 17-4 PH PER AMS 5943/22002,
CONDITION W1025.

2. REMOVE ALL BUBBS AND BREAK SWAMP COCKS. OILS/OILS.
3. MAGNETIC PARTICLE INSPECT PER MMS 21281, CL. A AND CRACKS ALLOWED.
4. PASSIVATE PER 88-P-30, TYPE II.

[illegible]



STYLING			
TOP	1/2	3/4	4/5



NOTES:

1. MATERIAL: ALUMINUM, 2024-T3 PER QQ-A-223/8.
2. REMOVE ALL BURRS AND BREAK SHARP EDGES. .0007-.018.
3. ANODIZE PER NAS PS 13201, TYPE II, CLASS I (MIL-A-8625).

[illegible]

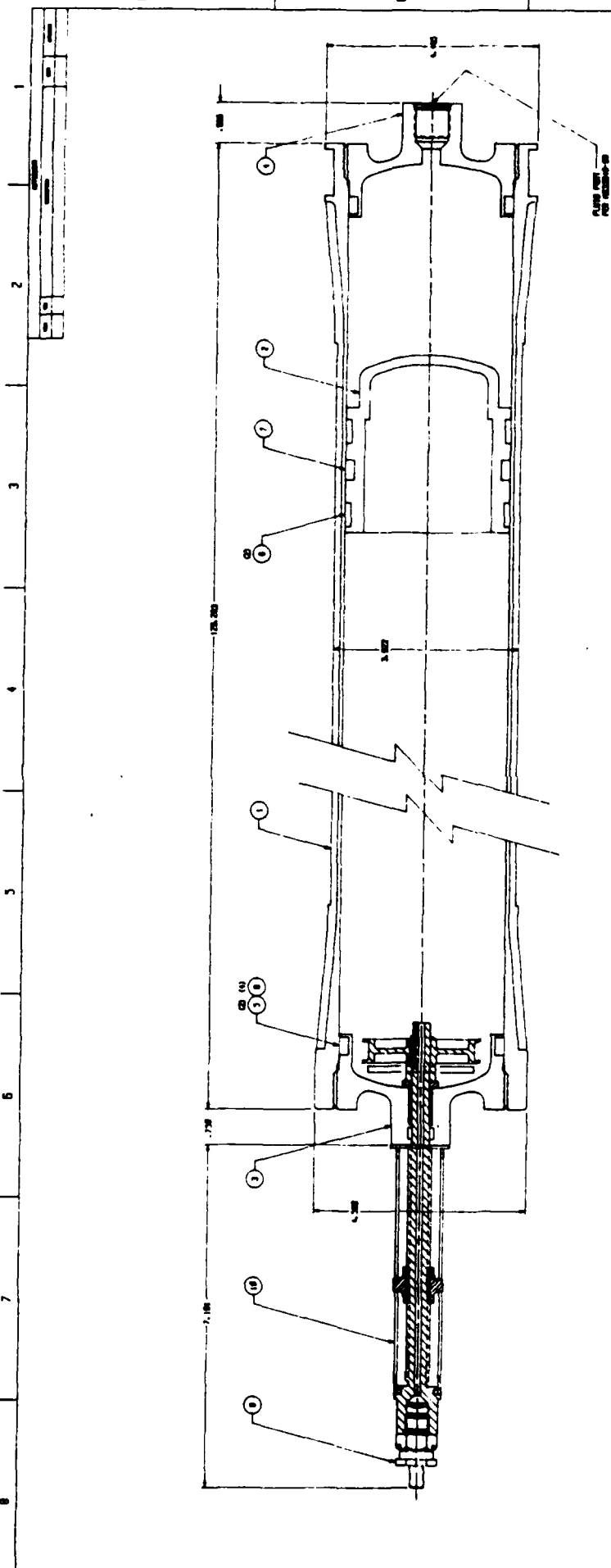
DESCRIPTION: EQUILIBRATION ACCUMULATOR (Obsolete)

NOTES:

1. OPERATING MEDIA: HYDRAULIC FLUID PER MIL-H-8320
NITROGEN PER MIL-H-811.
2. PRESSURES:
GAS CHARGE : 2700 PSIG
WORKING : 3000 PSIG
HYDRAULIC : 3000 PSIG
PISTON : 3000 PSIG
BURST : 15000 PSIG
3. TEMPERATURE: NON-OPERATING : MINUS 70 TO 100 F
OPERATING : MINUS 25 TO 100 F
4. VOLUME: GAS - 1200 CU. IN. MIN.
5. FLOWRATE: 20 GPM

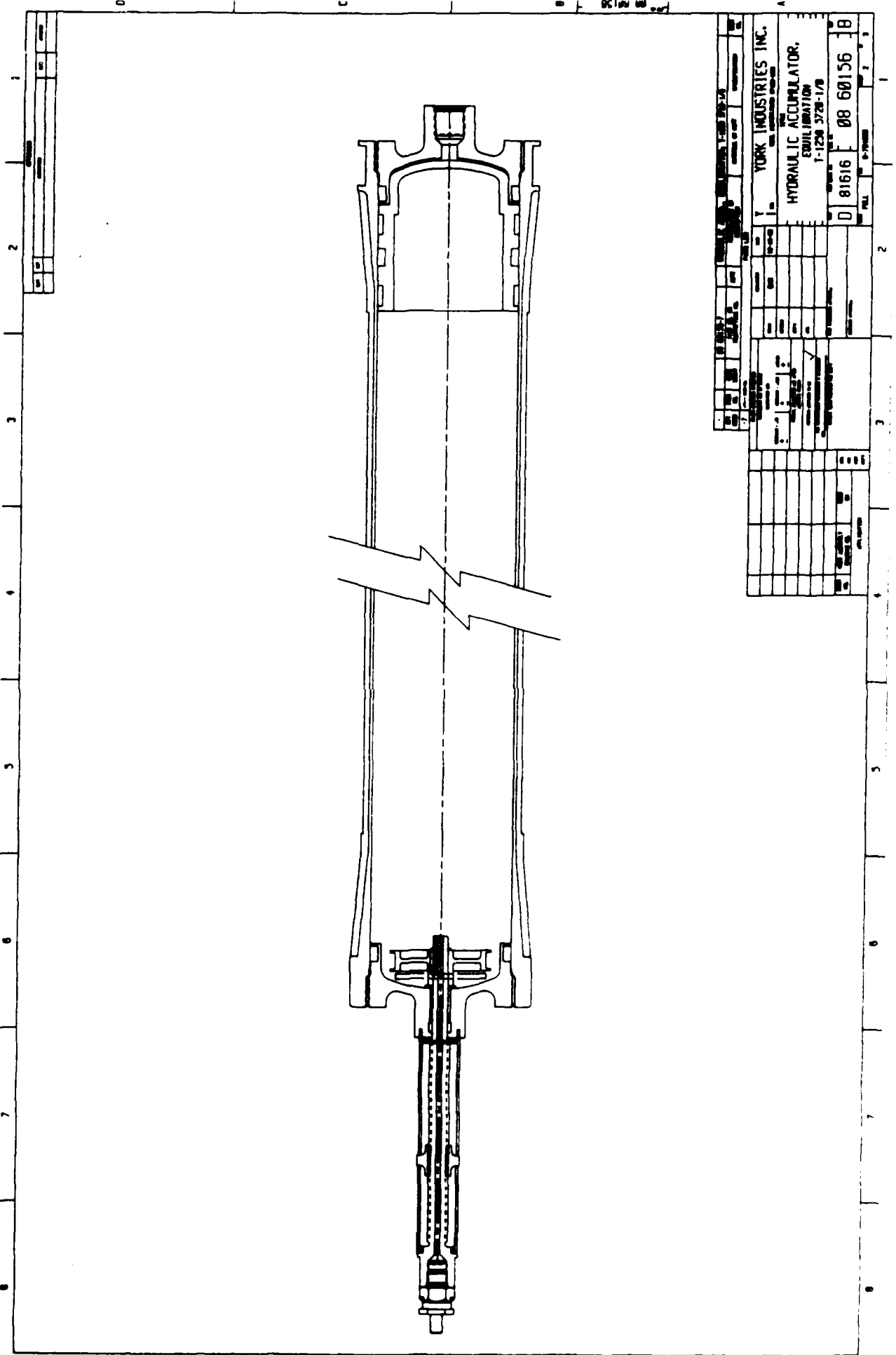
PARTS LIST		QUANTITY		DESCRIPTION		UNIT		REMARKS	
QTY	UNIT	QTY	UNIT	DESCRIPTION	DESCRIPTION	UNIT	REMARKS	QTY	UNIT
1	10	00 4037-7		POSITION INDICATOR ASST	INDICATOR				
		00 4038-7		INDICATOR	INDICATOR				
		00 4039-7		SEAL RING	SEAL RING				
		37022-110 01		PISTON	PISTON				
		30763		WASHER, THRUST	WASHER, THRUST				
		00 4074-7		WASHER	WASHER				
		00 4073-7		ROD END	ROD END				
		00 4072-7		ROD END, INDICATOR	ROD END, INDICATOR				
		00 4071-7		PISTON	PISTON				
		00 3007-7		CABLE	CABLE				
		00 3006-7		SPRING	SPRING				
1	9	30109		FITTING, GAS PORT	FITTING, GAS PORT				
2	8	30110-01004		WASHER	WASHER				
1	7	37022-308 01		SEAL RING	SEAL RING				
4	6	30012-220		BACK-UP RING	BACK-UP RING				
2	3	30001-220		O-RING	O-RING				
1	4	00 4070-7		END CAP, OIL	END CAP, OIL				
1	3	00 4069-7		END CAP, GAS	END CAP, GAS				
1	2	00 4068-7		PISTON ASST	PISTON ASST				
		00 4067-7		CABLE ATTACH	CABLE ATTACH				
1	1	00 4066-7		PISTON, MACHINE	PISTON, MACHINE				
		00 4065-7		CYLINDER ASST	CYLINDER ASST				
		00 4064-7		CYLINDER	CYLINDER				
		00 00130-7		HYDRAULIC ACCUMULATOR, EQUILIBRATION	HYDRAULIC ACCUMULATOR, EQUILIBRATION				
		00 00130-7		HYDRAULIC ACCUMULATOR, EQUILIBRATION	HYDRAULIC ACCUMULATOR, EQUILIBRATION				

YORK INDUSTRIES INC.		YORK INDUSTRIES INC.	
HYDRAULIC ACCUMULATOR, EQUILIBRATION		HYDRAULIC ACCUMULATOR, EQUILIBRATION	
1-1258 5720-1/C		1-1258 5720-1/C	
C 81616		C 81616	
08 60156		08 60156	
C		C	

[illegible]

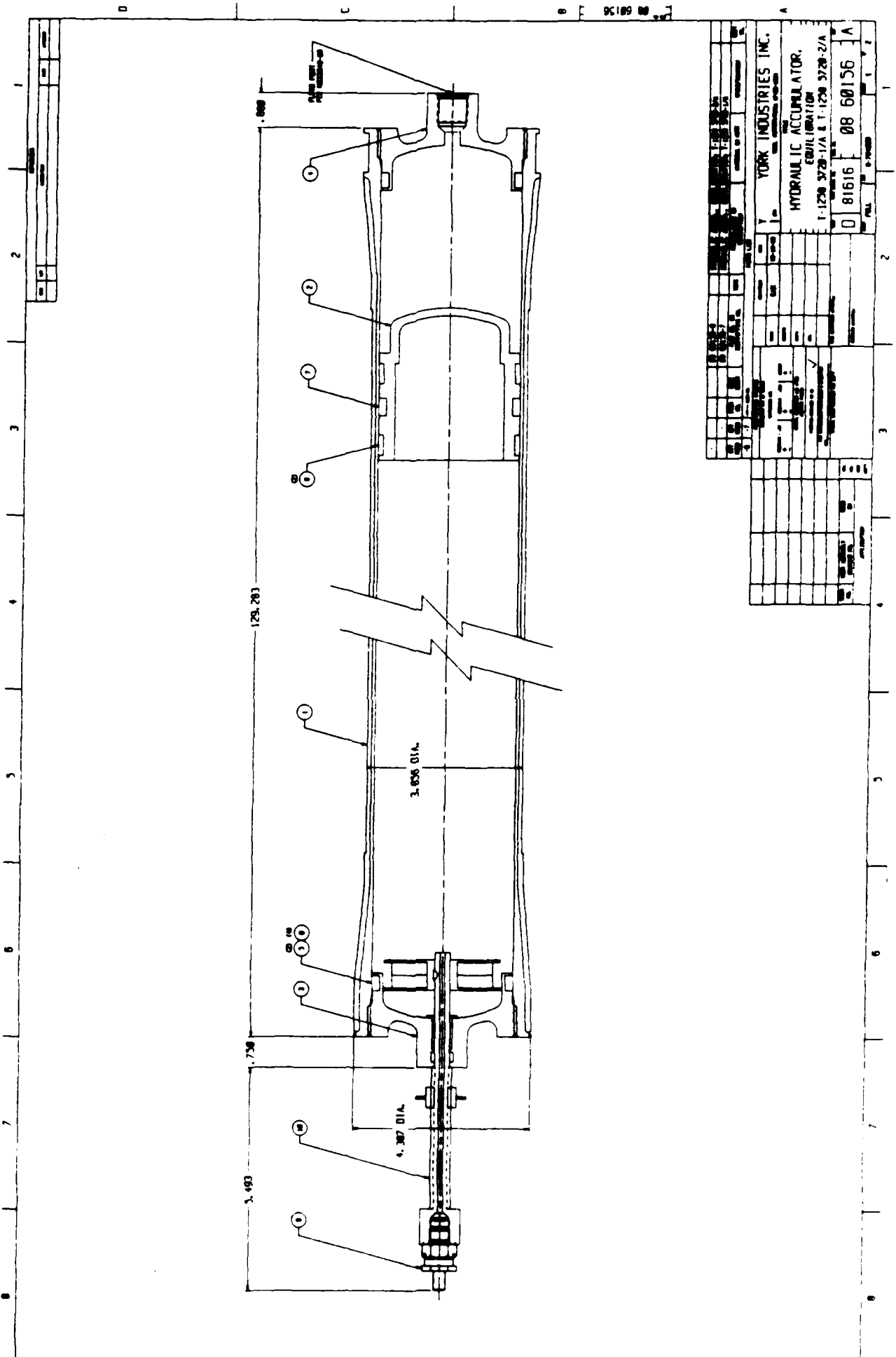
1. OPERATING MEDIA: INTERCALIC FLUORIDE PER MIL - 400000
IN TRENCH PER 100-411.
2. PRECIPITATES: GAS CHARGE - 2700 PSIG
WATERING - 5000 PSIG
PAIL OPERATING - 6000 PSIG
PUMP - 6000 PSIG
GUST - 15000 PSIG
3. TEMPERATURE: HOT-OPERATING - RINGS 70 TO 100 F
OPERATING - RINGS 25 TO 100 F
4. VOLUME: GAS - 1200 CU. IN. MIN.
5. FLOWRATE: 20 GPM

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— 125.430 —



YORK INDUSTRIES INC.		HYDRAULIC ACCUMULATOR		EQUILIBRATION		1-1250 3728-1/A & 1-1250 3728-2/A	
0 81616		08 60156		A		A	
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5		6		7		8	
9		10		11		12	
13		14		15		16	
17		18		19		20	
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125.430



YORK INDUSTRIES INC.		YORK INDUSTRIES INC.	
ACCUMULATOR, EQUILIBRATION		ACCUMULATOR, EQUILIBRATION	
T-1250 3720-001/A		T-1250 3720-001/A	
0 81616		0 81616	
08 60156		08 60156	

DESCRIPTION: RESERVOIR ACCUMULATOR

STATUS - PER YORK:

The concept drawing for the feed accumulator is complete and the assembly drawing was being revised to change the length of the accumulator to facilitate its mounting to the slide. This component meets its weight budget and was in fabricability review. The length of the cylinder of this accumulator was set by the need to match the length of the Equilibration Accumulator as a means to minimize overall system weight.

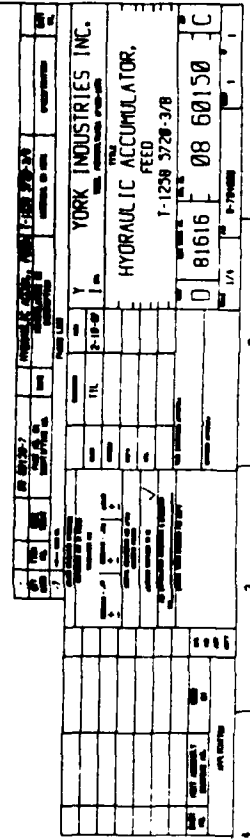
NOTES:

1. OPERATING MEDIA: HYDRAULIC FLUID PER MIL-H-8082A.
NITROGEN PER 88-H-111.
2. PRESSURE: GAS CHARGE : 120 PSIG
WORKING : 200 PSIG
MAX. OPERATING : 300 PSIG
MAX. SURGE : 340 PSIG
BURST : 1440 PSIG
3. TEMPERATURE: NON-OPERATING : RINGS 70 TO 100° F
OPERATING : RINGS 23 TO 100° F
MAX. FLUID : 200° F
4. VOLUME: GAS : 0000 CU. IN. MIN.
5. FLOWRATE: 130 GPM

ITEM NO.		QUANTITY		DESCRIPTION		UNIT		REMARKS	
1	13	20012-227 82		BACK-UP RING				REWORK-227	
2	12	20011-227		O-RING				REWORK-227	
1	11	00 40506-7		SLIP RING					
1	10	00 40577-7		POSITION INDICATOR ASST					
		00 40578-7		INDICATOR					
		00 40579-7		SWIFT					
		27022-110 81 81T		SEAL RING					
		20073		WASHER, THRUST					
		00 40574-7		WHEEL					
		00 40573-7		ROSHINE					
		00 40572-7		ROSHINE, INDICATOR					
		00 40571-7		PISTON					
		00 30007-7		CABLE					
		00 30008-7		SPRING					
1	9	30108		FITTING, GAS PORT					
2	8	20310-00078		SEAL BAND				CARBON-FILLED TFE	
1	7	27022-140 81 81T		SEAL RING					
1	6	20012-140 82		BACK-UP RING				REWORK-140	
2	5	20001-140		O-RING				REWORK-140	
1	4	00 40570-7		END CAP, OIL					
1	3	00 40508-7		END CAP, GAS					
1	2	00 40501-7		PISTON ASST					
		00 40503-7		CABLE ATTACH					
1	1	00 40502-7		PISTON, MACHINE					
		00 40579-7		CYLINDER					
		00 00130-7		HYDRAULIC ACCUM. FEED: 1-1250 3720-3/8					
				REWORKING OR REDESCRIPTION					
PARTS LIST									
YORK INDUSTRIES INC.									
HYDRAULIC ACCUMULATOR, FEED									
T-1250 3720-3/8									
C 81616 08 60150 10									
08 60150 10									

E/131

DESCRIPTION: RESERVOIR ACCUMULATOR (Obsolete)



DESCRIPTION: BREECH ACTUATOR

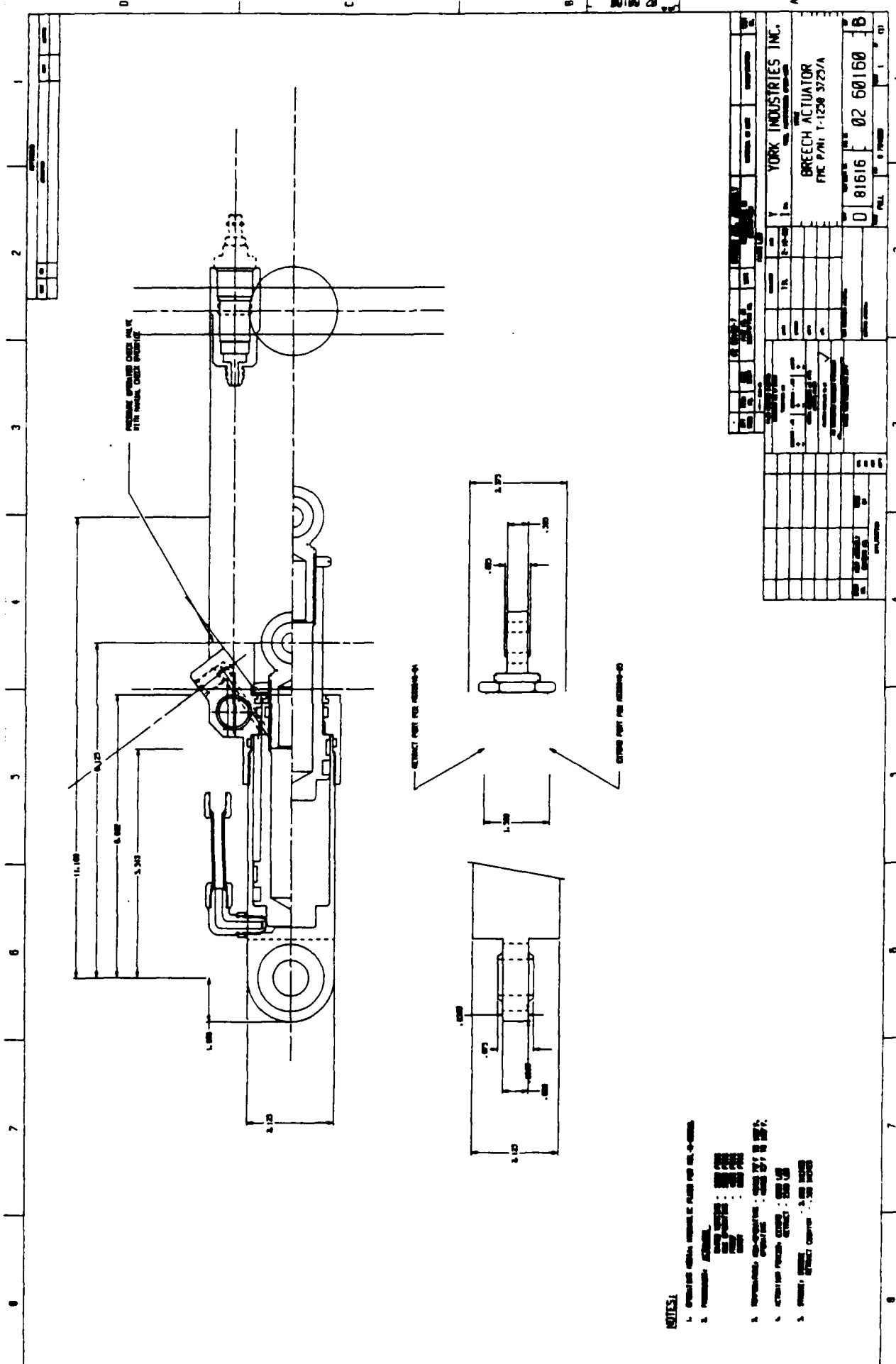
STATUS - PER YORK:

The concept drawing for the Breech Actuator had been completed and the assembly drawing was being revised to incorporate a check valve and FMC specified port locations. The pilot-operated check valve provides an extended stroke position lock when hydraulic pressure is removed from the unit. This unit meets its weight budget and no further weight reduction is required.

STATUS - PER FMC:

The pilot-operated check with manual override prevents accidental breech closure due to hose failure and facilitates manual opening and closing.

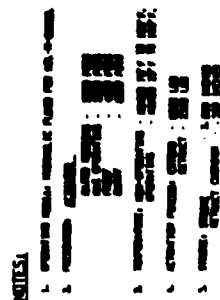
AUTHOR: Jeff Ireland/Bart Anderson



YORK INDUSTRIES INC.	
BREECH ACTUATOR	
P/N: 1-123 3725/A	
01616	02 60160 B

E/141

DESCRIPTION: BREECH ACTUATOR (Obsolete)



0	81616	02	60150	A
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DESCRIPTION: COUNTERRECOIL ACCUMULATOR - Left

STATUS - PER YORK:

The concept drawing for the left and right accumulators is approximately 90% complete; however, the increase in volume from 1600 cubic inches to 2400 inches drives its estimated weight above the target weight by a significant amount. In the interest of weight reduction, it is recommended that the factor of safety on maximum operating pressure for proof pressure be reduced from the standard value of 2.0 to a value of 1.5 and that the burst factor be reduced from 4.1 to 3.0 on the cylindrical section only. Design factors of safety for the end caps and threaded joints remain at the standard level of 4.0. FMC approval was obtained at the March 6, 1987, coordination meeting.

STATUS - PER FMC:

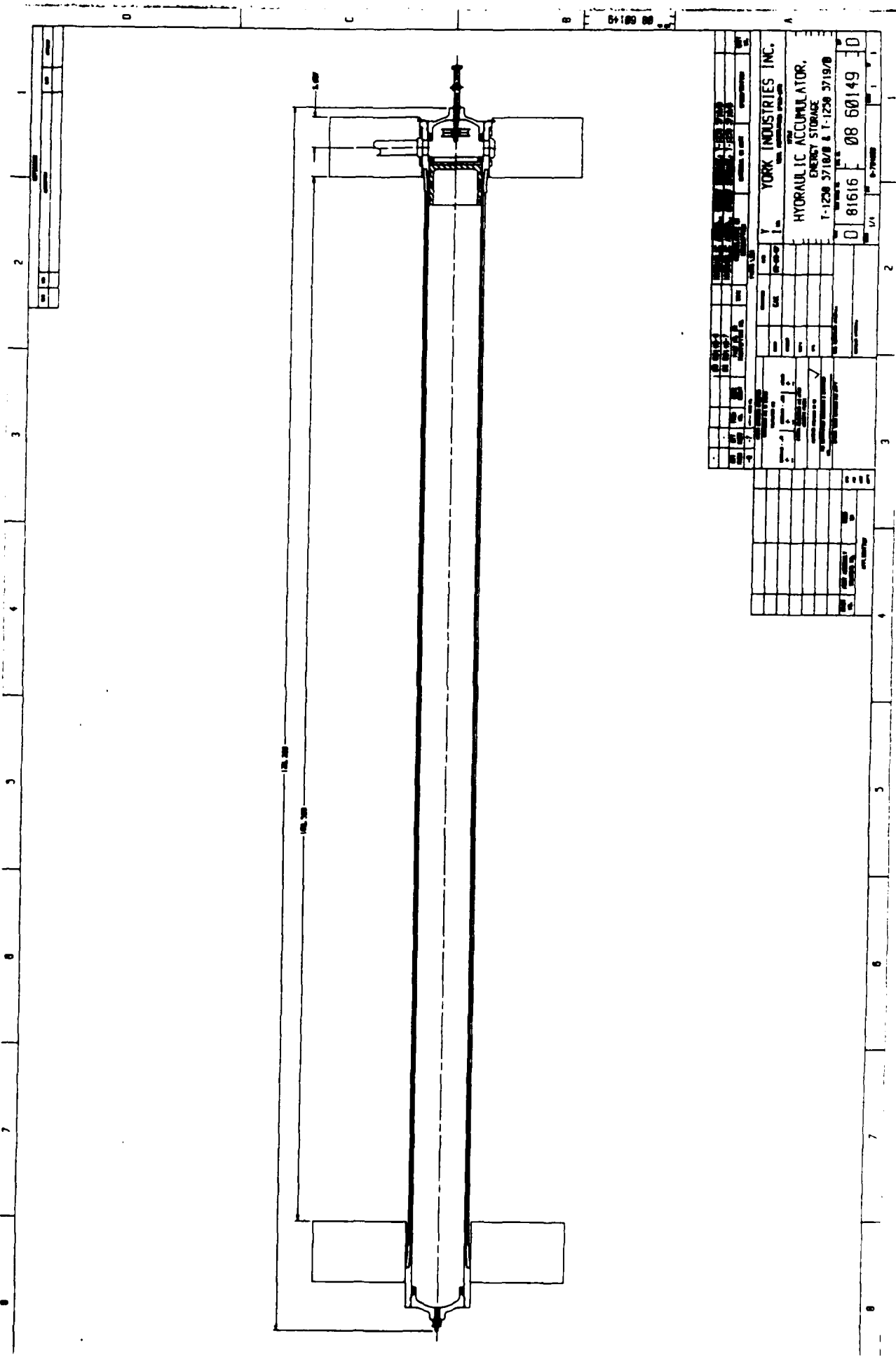
The volume increase was to accommodate the broad temperature range coupled with varying amounts of energy in storage (see C/120).

AUTHOR: Jeff Ireland/Bart Anderson

1. OPERATING MEDIA: HYDROLYC FLUID PER MIL. + GASES.
HYDROLYC FLUID PER MIL.
2. PRESSURES: GAS CHARGE : 300 PSIG
WORKING : 630 PSIG
PALL. OPERATING : 730 PSIG
SHUT DOWN : 1120 PSIG
BURST : 1600 PSIG
3. TEMPERATURE: HIGH-OPERATING : RINGS 70 TO 100° F
LOW-OPERATING : HEADS 70 TO 100° F
PALL. FLUID : 275° F
4. VOLUME : GAS - 2750 CU. IN. MIL.
FLUORINATE : TWO GPM

[illegible]

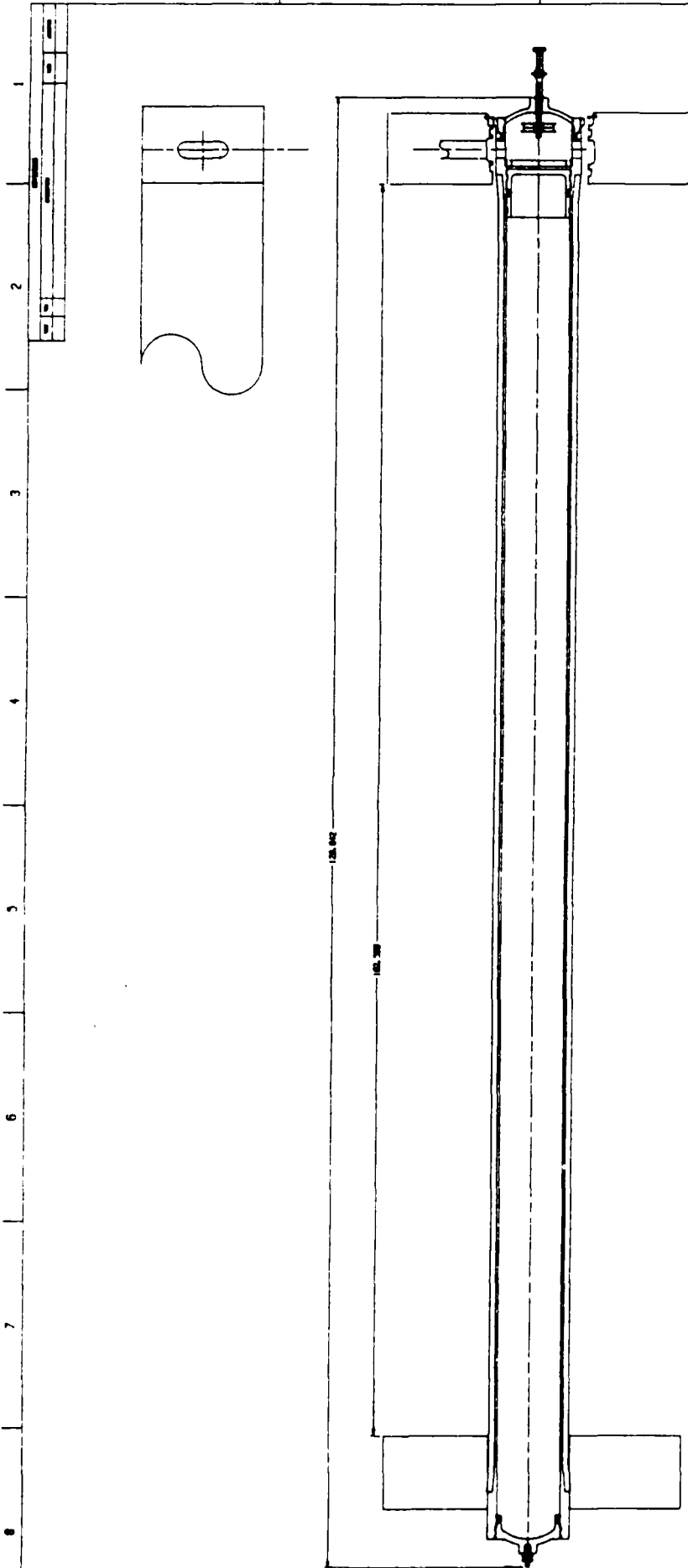
DESCRIPTION: COUNTERRECOIL ACCUMULATOR - Left (Obsolete)



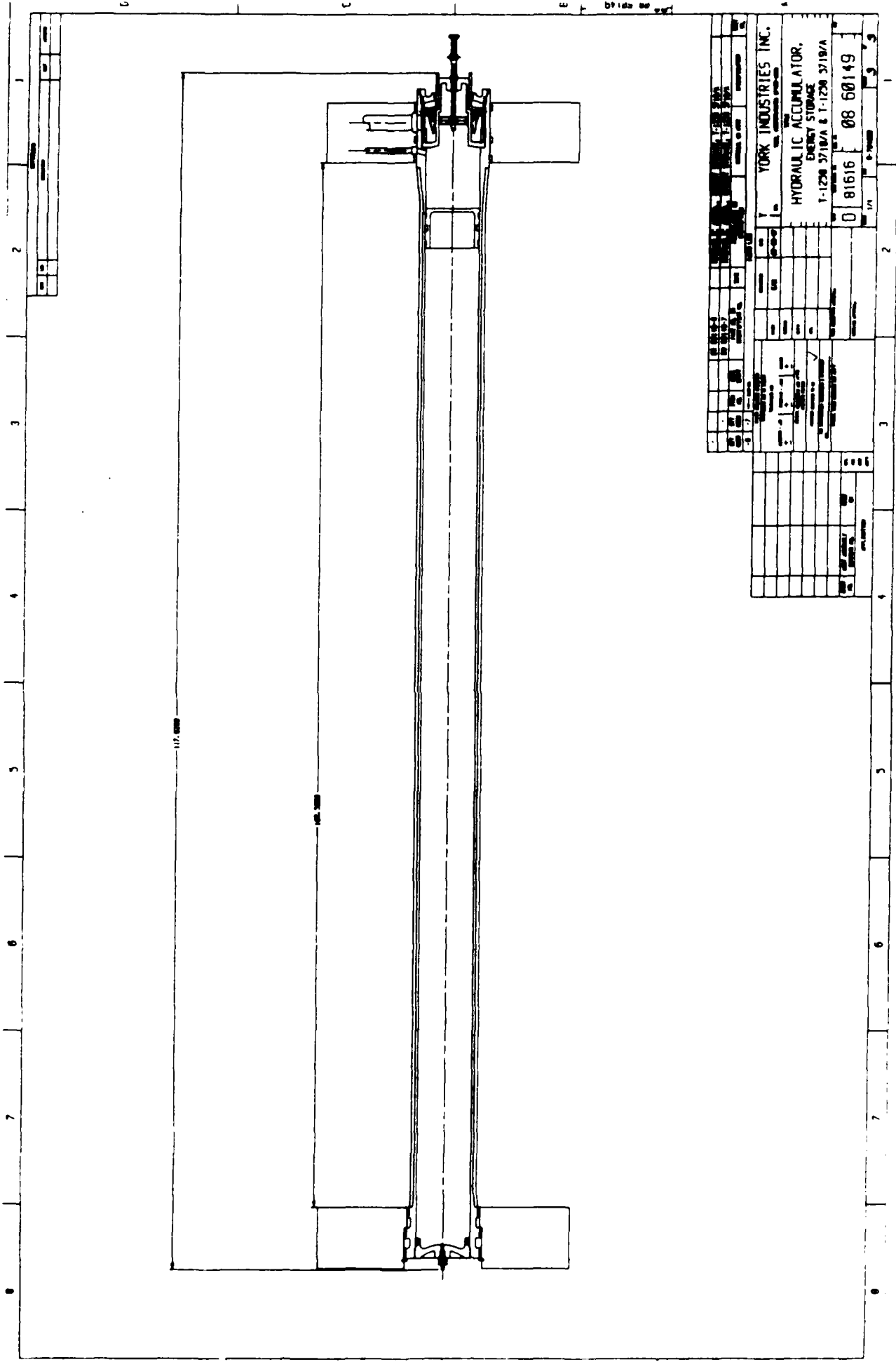
YORK INDUSTRIES INC.	
HYDRAULIC ACCUMULATOR, ENERGY STORAGE	
T-1250 3710/8 & T-1250 3719/8	
Q 81616	Ø8 60149
1/4	Ø8 60149

1. OPERATING MEDIA:	HYDRAULIC FLUID	PSD MIL-H-6800.
	NITROGEN	PS-411.
2. PRESSURES:	GAS CHARGE	3000 PSIG
	WORKING	4500 PSIG
	PAL. OPERATING	7500 PSIG
	PROOF	11250 PSIG
	BURST	30000 PSIG
3. TEMPERATURE:	NON-OPERATING	RANGES 70 TO 100° F
	OPERATING	RANGES 70 TO 100° F
	PAL. FLUID	275° F
4. VOLUME:	GAS	2200 CIL. IN. MIN.
5. FLOW RATE:	200 GPM	

[illegible]



BOM										ITEM										DESCRIPTION										QUANTITY										UNIT										REMARKS										DATE										BY										CHECKED										APPROVED										SIGNATURE										DATE										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REVISION										REV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YORK INDUSTRIES INC.		HYDRAULIC ACCUMULATOR, ENERGY STORAGE 1-129 3718/A & 1-129 3719/A	
Q 81616	08 60149		
1		2	
3		4	
5		6	
7		8	
9		10	
11		12	
13		14	
15		16	
17		18	
19		20	
21		22	
23		24	
25		26	
27		28	
29		30	
31		32	
33		34	
35		36	
37		38	
39		40	
41		42	
43		44	
45		46	
47		48	
49		50	
51		52	
53		54	
55		56	
57		58	
59		60	
61		62	
63		64	
65		66	
67		68	
69		70	
71		72	
73		74	
75		76	
77		78	
79		80	
81		82	
83		84	
85		86	
87		88	
89		90	
91		92	
93		94	
95		96	
97		98	
99		100	

E/160

DESCRIPTION: COUNTERRECOIL ACCUMULATOR - Right

STATUS - See E/150

DESCRIPTION: ELEVATION ACTUATOR**STATUS - PER YORK:**

A single actuator, attached to the center of the slide, was substituted for the original one on each side and the stroke was lengthened. The concept drawing for the revised stroke was completed and was in review for fabrication evaluation. The project weight of this actuator meets its weight budget; however, further reduction was planned to allow for the weight growth in the Counter-recoil Accumulators as previously discussed later. Tailoring of cushioning at end of stroke is planned whenever the acceleration requirements become defined.

STATUS - PER FMC:

See B/700 pg. 19 for logic behind change from two to one elevation cylinder. End-of-stroke cushion is part of the dynamic analysis of elevation and equilibration (C/110).

AUTHOR: Jeff Ireland/Bart Anderson

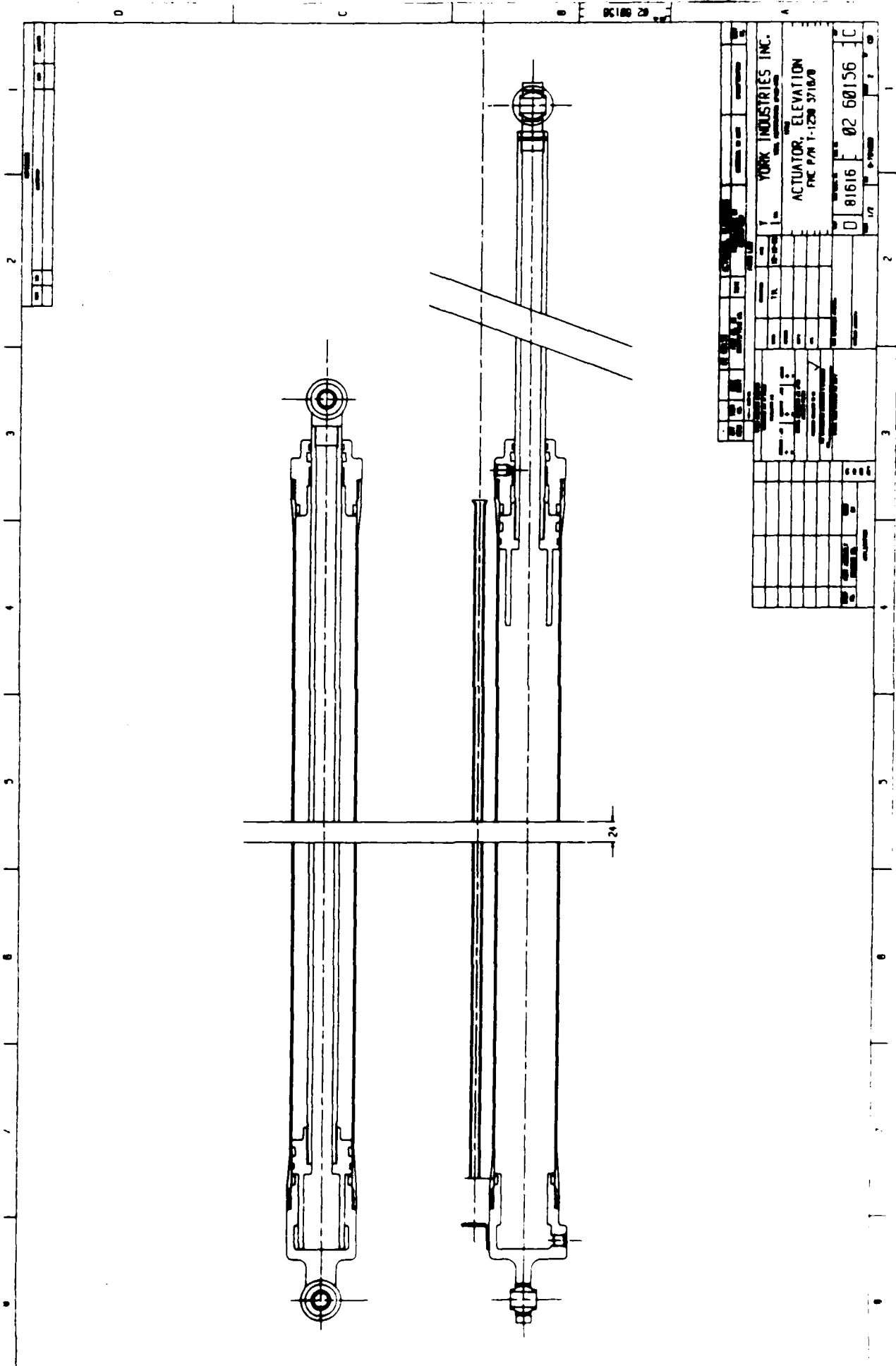
NOTES:

1.

REV		DATE		BY		DESCRIPTION	
1	12						RED SEAL
1	11						SCRAMPER RING
1	10						END CAP, RED
2	9						SPHERICAL BEARING
1	8						PISTON MOUNT
1	7						PISTON
1	6						SEAL RING
2	5						BEAR RING
1	4						CYLINDER ASSEMBLY
1	3						CYLINDER TUBE
1	2						BACK-UP RING
1	1						END CAP, MOUNTING
1	0						ACTUATOR, ELEVATION ADJUST

QTY	UNIT	DESCRIPTION	REVISION	DATE	BY
1	EA	ACTUATOR, ELEVATION ADJUST			
1	EA	END CAP, MOUNTING			
1	EA	BACK-UP RING			
1	EA	CYLINDER TUBE			
1	EA	CYLINDER ASSEMBLY			
1	EA	BEAR RING			
1	EA	SEAL RING			
1	EA	PISTON			
1	EA	PISTON MOUNT			
1	EA	SPHERICAL BEARING			
1	EA	END CAP, RED			
1	EA	SCRAMPER RING			
1	EA	RED SEAL			

YORK INDUSTRIES INC.	
ACTUATOR, ELEVATION ASSEMBLY	81616 02 60156
81616 02 60156	02 60156



YORK INDUSTRIES INC.	
ACTUATOR, ELEVATION	
P/N 1-123 3710/0	
Q 81616	Ø2 60156
C	

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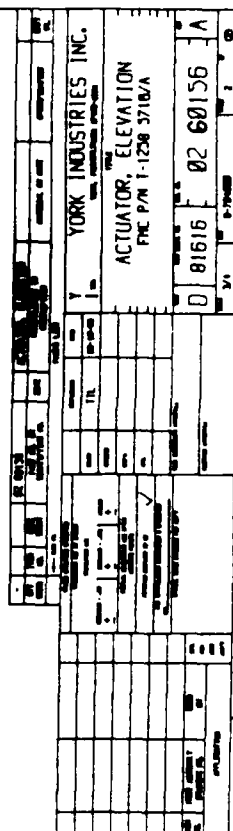
02 60156

E/171

DESCRIPTION: ELEVATION ACTUATOR (Obsolete)

—

02 68156



2

NOTES:

1.

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	12	30000-11	RED SEA				
1	11	30000-1	SCRAMPER RING				
1	10	62 48000-7	END CAP, RED				
2	9	30000-1	SPHERICAL BEARING				
1	8	62 48000-7	PISTON MOUNT				
1	7	62 48000-7	PISTON				
1	6	37000 308 00	PISTON, MACHINE				
2	5	62 48000-7	PISTON, RED				
1	4	62 48000-7	SEAL RING				
1	3	62 48000-7	WEAR RING				
1	2	62 48000-7	CYLINDER ASSEMBLY				
1	1	62 48000-7	CYLINDER, MACHINE				
1	0	62 48000-100	CYLINDER, TUBE				
1	0	30000 308	CYLINDER MOUNT, VERTICAL				
2	0	30000 143 01	BACK-UP RING				
1	0	62 48000-7	O-RING				
1	0	62 48000-7	END CAP, POLYMER				
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

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NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

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NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

REVISED		DATE		BY		APP'D	
NO.	REV.	DATE	BY	DATE	BY	DATE	BY
1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

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1	0	62 48000-7	ACTUATOR, ELEVATION ASSEMBLY				

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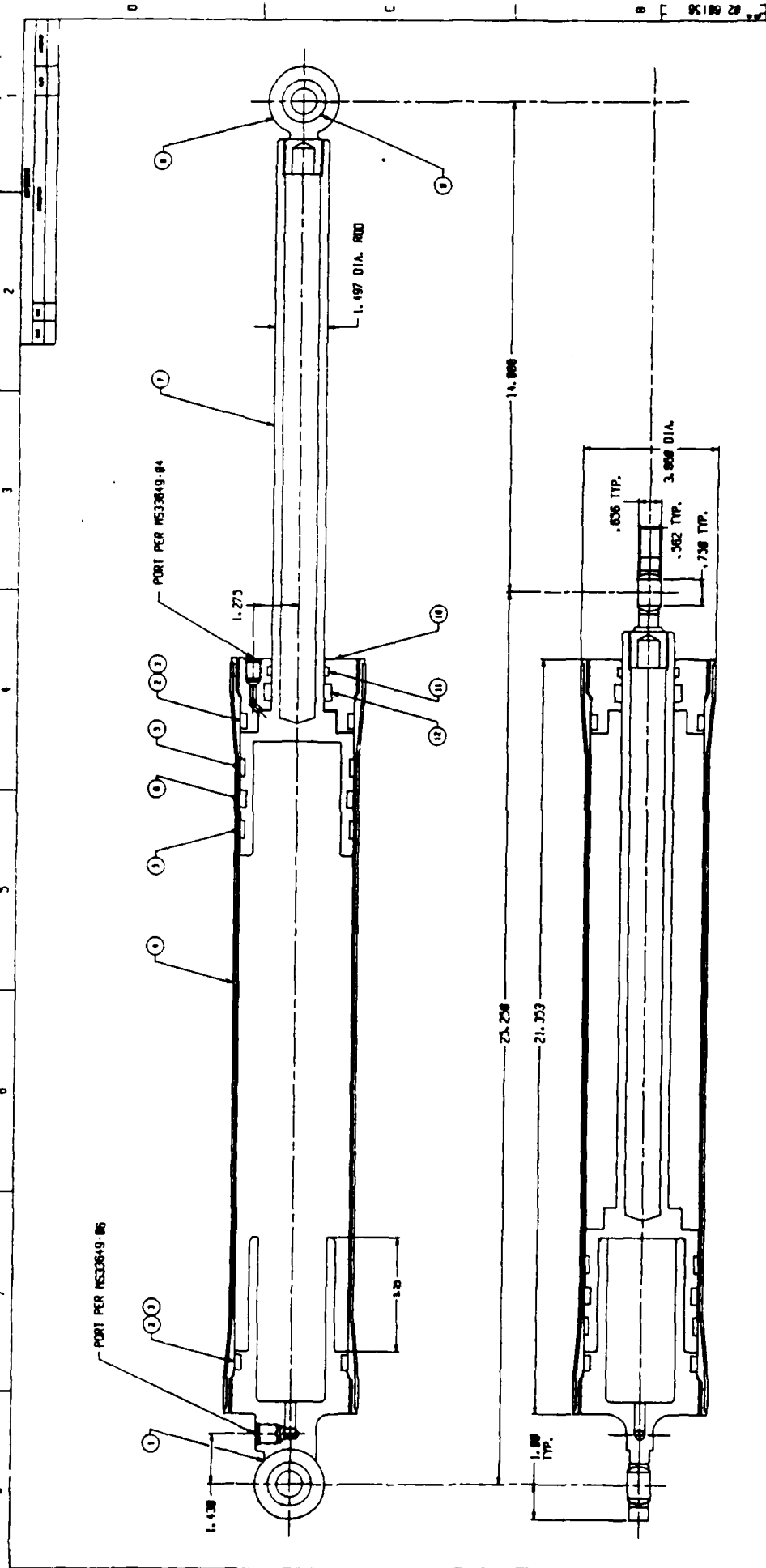
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1	0	62 48000-7	ACTUATOR				



YORK INDUSTRIES INC.									
ACTUATOR, ELEVATION									
P/N T-1258 5718/A									
0 81616 02 60156									

DESCRIPTION: ELEVATION AND TRAVERSE SYSTEM PERFORMANCE SUMMARY

STATUS - PER YORK:

An analysis of the static and dynamic performance of the hydraulic systems for elevation and traverse was planned for this program, but was suspended midway through the program so that available resources could be applied to the basis design of the components. Initial results are provided for the early configuration. No effort was expended and, therefore, no results are available which evaluate the fluid inertia effects incurred by operation of the hydraulic subsystems.

STATUS - PER FMC:

Don Sweitzer of York and John Green of FMC conferred on equilibration system analysis. York's analysis efforts tapered off as the FMC model and York model began to provide similar results. See Section C/110 (Elevation and Equilibration), C/240 (Traverse Actuator), and C/260 (Tube Laying Accuracy).

AUTHOR: Jeff Ireland/Bart Anderson

ELEVATION SYSTEM PERFORMANCE SUMMARY

5/10/87

13: 8:29

EQUILIBRATION CYLINDER PARAMETERS:

PISTON DIAMETER	INCH	3.125
ROD DIAMETER	INCH	2.500
RETRACT PRESSURE AREA	IN ²	2.761
STROKE	INCH	44.670
NOMINAL OPERATING PRESSURE	PSIG	5200.
RETRACT FORCE AT NOMINAL PRESSURE	LBS	28716.
MAXIMUM OPERATING PRESSURE	PSIG	5600.
RETRACT FORCE AT MAXIMUM PRESSURE	LBS	30925.
RETRACT FLOWRATE - RATED	GPM	8.54

ELEVATION CYLINDER PARAMETERS:

PISTON DIAMETER	INCH	3.250
ROD DIAMETER	INCH	1.500
STROKE	INCH	38.567
MINIMUM OPERATING PRESSURE	PSIG	3000.
EXTEND FORCE AT MINIMUM PRESSURE	LBS	24887.
RETRACT FORCE AT MINIMUM PRESSURE	LBS	19586.
MAXIMUM OPERATING PRESSURE	PSIG	3200.
EXTEND FORCE AT MAXIMUM PRESSURE	LBS	26546.
RETRACT FORCE AT MAXIMUM PRESSURE	LBS	20892.
EXTEND FLOWRATE - RATED	GPM	72.540
RETRACT FLOWRATE - RATED	GPM	92.175

EQUILIBRATION ACCUMULATOR PARAMETERS:

ACCUMULATOR VOLUME	IN ³	1200.00
CHARGE PRESSURE AT 70 deg-F	PSIA	2800.00
STARTING PRESSURE AT 0 Q.E.	PSIA	5200.00

SYSTEM CONFIGURATION PARAMETERS:

PIVOT COORDINATES	INCH	0.000	0.000
EQUILIBRATION FIXED MOUNT	INCH	-2.000	35.500
EQUILIBRATION MOVABLE END 0 Q.E.	INCH	242.250	-8.500
ELEVATION CYLINDER FIXED MOUNT	INCH	161.750	3.100
ELEVATION CYLINDER MOVABLE END AT 0 Q.E.	INCH	-10.000	35.000
CENTER OF GRAVITY COORDINATES	INCH	96.000	18.500
ELEVATING WEIGHT	LBS	6077.00	
MASS MOMENT OF INERTIA	SLUG-FT ²	41230.0	

ELEVATION SYSTEM PERFORMANCE SUMMARY

5/10/87

13: 8:29

	ELEVATION START	ELEVATION END	EQUILIBRATE PRESSURE MAX	EQUILIBRATE PRESSURE MIN	RETRACT PRESS	EXTEND PRESS	SLANT ANGLE	TEMPERATURE TRUE	TEMPERATURE EQUIL
ISO	0.	72.	5200.	3738.	1216.	345.	0.	70.	70.
ISO	0.	72.	5200.	4041.	1201.	404.	0.	160.	160.
ISO	0.	72.	5200.	3335.	1347.	283.	0.	-25.	-25.
ISO	0.	72.	4725.	3486.	1559.	345.	0.	70.	120.
ISO	0.	72.	4637.	3097.	1652.	283.	0.	-25.	25.
ISO	0.	72.	5416.	3848.	1085.	345.	0.	70.	50.
ISO	0.	72.	5386.	4152.	1047.	403.	0.	160.	140.
ISO	0.	72.	5200.	3738.	886.	1821.	18.	70.	70.
ISO	0.	72.	5200.	4041.	951.	2021.	18.	160.	160.
ISO	0.	72.	5200.	3335.	818.	1567.	18.	-25.	-25.
ISO	0.	72.	5200.	3738.	1827.	345.	-10.	70.	70.
ISO	0.	72.	5200.	4041.	1706.	404.	-10.	160.	160.
ISO	0.	72.	5200.	3335.	2009.	283.	-10.	-25.	-25.
ADIA	0.	72.	5200.	3266.	1435.	365.	0.	70.	70.
ADIA	0.	72.	5200.	3596.	1327.	427.	0.	160.	160.
ADIA	0.	72.	5200.	2828.	1621.	300.	0.	-25.	-25.
ADIA	0.	72.	4725.	3085.	1671.	365.	0.	70.	120.
ADIA	0.	72.	4637.	2677.	1836.	300.	0.	-25.	25.
ADIA	0.	72.	5416.	3344.	1344.	365.	0.	70.	50.
ADIA	0.	72.	5386.	3680.	1229.	427.	0.	160.	140.
ADIA	0.	72.	5200.	3266.	886.	1597.	18.	70.	70.
ADIA	0.	72.	5200.	3596.	951.	1813.	18.	160.	160.
ADIA	0.	72.	5200.	2828.	865.	1322.	18.	-25.	-25.
ADIA	0.	72.	5200.	3266.	2158.	365.	-10.	70.	70.
ADIA	0.	72.	5200.	3596.	2023.	427.	-10.	160.	160.
ADIA	0.	72.	5200.	2828.	2359.	300.	-10.	-25.	-25.
ADIA	72.	0.	6228.	4033.	301.	1621.	0.	70.	70.
ADIA	72.	0.	5827.	4177.	352.	1381.	0.	160.	160.
ADIA	72.	0.	6873.	3834.	247.	2027.	0.	-25.	-25.
ADIA	72.	0.	5585.	3741.	301.	1173.	0.	70.	120.
ADIA	72.	0.	5978.	3519.	247.	1404.	0.	-25.	25.
ADIA	72.	0.	6525.	4162.	301.	1827.	0.	70.	50.
ADIA	72.	0.	6052.	4296.	352.	1538.	0.	160.	140.
ADIA	72.	0.	6228.	4033.	301.	2827.	18.	70.	70.
ADIA	72.	0.	5827.	4177.	352.	2936.	18.	160.	160.
ADIA	72.	0.	6873.	3834.	247.	2689.	18.	-25.	-25.
ADIA	72.	0.	6228.	4033.	360.	1663.	-10.	70.	70.
ADIA	72.	0.	5827.	4177.	352.	1424.	-10.	160.	160.
ADIA	72.	0.	6873.	3834.	429.	2070.	-10.	-25.	-25.

DYNAMIC ANALYSIS
ENERGY RECOVERY ELEVATION - Adiabatic

5/10/87
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EQUILIBRATION CYLINDER PARAMETERS:

PISTON AREA (2)	IN ²	5.522
EQUILIBRATION ACCUMULATOR VOLUME	IN ³	1200.00
AMBIENT TEMPERATURE	deg-F	70.00
CHARGE PRESSURE AT 70 deg-F	PSIA	2800.00
STARTING PRESSURE AT 0 Q.E.	PSIA	5200.00
OIL VOLUME ADJUSTMENT FROM 70 deg-F	IN ³	0.00

ELEVATION CYLINDER PARAMETERS:

STARTING DECELERATION PRESSURE	PSIA	3000.000
MAXIMUM DECELERATION TORQUE	FT-LB	10000.000
ENERGY STORE ACCUM GAS VOLUME	IN ³	2400.000
ENERGY STORE ACCUM PRESSURE	PSIA	3000.000
PISTON DIAMETER	INCH	3.250
ROD DIAMETER	INCH	1.500

SYSTEM PARAMETERS:

STARTING ELEVATION (THETA ₀)	DEGREES	0.000
ENDING ELEVATION (THETA _f)	DEGREES	72.000
ELEVATING WEIGHT	LBS	6077.000
MASS MOMENT OF INERTIA (I)	SLUG-FT ²	41230.000

TIME	ANGLE	EXTEND	RETRACT	EQUIL	ANGULAR	EXTEND	RETRACT	
SEC	DEGREE	PRESS	PRESS	PRESS	VELOCITY	FLOW	FLOW	
		PSIA	PSIA	PSIA	DEG/SEC	GPM	GPM	
0.001	0.000	300.5	3000.0	5200.0	0.023	0.000	0.000	1
0.100	0.231	356.1	2944.6	5190.3	4.548	5.634	4.434	1
0.200	0.892	497.8	2803.4	5162.3	8.508	10.615	8.354	1
0.300	1.903	668.9	2633.1	5119.8	11.535	14.502	11.413	1
0.400	3.168	821.2	2481.7	5067.0	13.594	17.236	13.564	1
0.500	4.596	933.6	2370.5	5008.1	14.850	18.995	14.949	1
0.600	6.119	1005.9	2299.4	4946.1	15.530	20.039	15.771	1
0.700	7.690	1047.3	2259.3	4883.1	15.835	20.605	16.216	1
0.800	9.279	1068.0	2240.0	4820.3	15.916	20.872	16.426	1
0.900	10.869	1075.8	2233.5	4758.4	15.869	20.961	16.496	1
1.000	12.450	1076.3	2234.3	4698.0	15.758	20.950	16.487	1
1.100	14.019	1072.9	2239.1	4639.1	15.617	20.884	16.435	1
1.200	15.573	1067.6	2245.8	4581.8	15.468	20.792	16.363	1
1.300	17.113	1061.5	2253.3	4526.0	15.321	20.688	16.281	1
1.400	18.638	1055.3	2260.9	4471.9	15.185	20.583	16.198	1
1.500	20.150	1049.3	2268.3	4419.2	15.060	20.480	16.118	1
1.600	21.650	1043.7	2275.2	4368.0	14.950	20.383	16.041	1
1.700	23.140	1038.6	2281.7	4318.1	14.854	20.291	15.969	1

DYNAMIC ANALYSIS							5/10/87	
ENERGY RECOVERY ELEVATION - Adiabatic								
TIME	ANGLE	EXTEND	RETRACT	EQUIL	ANGULAR	EXTEND	RETRACT	
SEC	DEGREE	PRESS	PRESS	PRESS	VELOCITY	FLOW	FLOW	
		PSIA	PSIA	PSIA	DEG/SEC	GPM	GPM	
1.800	24.622	1034.0	2287.6	4269.6	14.772	20.207	15.903	1
1.900	26.095	1030.0	2293.1	4222.3	14.706	20.130	15.842	1
2.000	27.563	1026.5	2298.0	4176.3	14.654	20.060	15.787	1
2.100	29.027	1023.5	2302.4	4131.4	14.617	19.996	15.737	1
2.200	30.487	1020.9	2306.4	4087.6	14.595	19.939	15.692	1
2.300	31.946	1018.8	2309.9	4044.9	14.587	19.889	15.652	1
2.400	33.405	1017.1	2313.0	4003.2	14.594	19.844	15.617	1
2.500	34.865	1015.9	2315.7	3962.5	14.617	19.805	15.586	1
2.600	36.329	1015.0	2318.0	3922.7	14.655	19.771	15.559	1
2.700	37.797	1014.4	2320.0	3883.8	14.709	19.742	15.537	1
2.800	39.271	1014.2	2321.7	3845.8	14.780	19.718	15.518	1
2.900	40.754	1014.3	2323.1	3808.7	14.869	19.698	15.502	1
3.000	42.246	1014.6	2324.2	3772.4	14.976	19.681	15.489	1
3.100	43.750	1015.2	2325.2	3736.8	15.103	19.667	15.478	1
3.200	45.267	1015.9	2325.9	3702.1	15.252	19.656	15.469	1
3.300	46.801	1016.8	2326.6	3668.1	15.424	19.647	15.462	1
3.400	48.353	1017.7	2327.2	3634.8	15.622	19.638	15.455	1
3.500	49.926	1018.6	2327.8	3602.2	15.847	19.629	15.448	1
3.600	51.523	1019.4	2328.6	3570.4	16.103	19.618	15.439	1
3.700	53.148	1020.0	2329.6	3539.2	16.393	19.604	15.428	1
3.800	54.804	1020.1	2331.0	3508.7	16.722	19.583	15.411	1
3.900	56.481	1421.6	1931.1	3479.1	16.345	18.711	14.725	3
4.000	58.032	1406.3	1947.8	3452.9	14.727	16.464	12.957	3
4.100	59.431	1392.4	1962.9	3430.2	13.270	14.494	11.407	3
4.200	60.691	1379.9	1976.6	3410.5	11.957	12.769	10.049	3
4.300	61.826	1368.4	1989.0	3393.4	10.774	11.258	8.860	3
4.400	62.849	1358.0	2000.3	3378.5	9.708	9.935	7.819	3
4.500	63.770	1348.4	2010.7	3365.5	8.747	8.776	6.907	3
4.600	64.601	1339.6	2020.2	3354.1	7.882	7.761	6.108	3
4.700	65.349	1331.5	2028.9	3344.2	7.102	6.871	5.407	3
4.800	66.023	1324.1	2036.9	3335.4	6.399	6.089	4.792	3
4.900	66.631	1317.2	2044.2	3327.6	5.766	5.403	4.252	3
5.000	67.178	1310.9	2050.9	3320.8	5.195	4.799	3.776	3
5.100	67.672	1305.1	2057.1	3314.8	4.681	4.266	3.357	3
5.200	68.116	1299.8	2062.7	3309.4	4.218	3.797	2.988	3
5.300	68.516	1295.0	2067.9	3304.7	3.801	3.382	2.662	3
5.400	68.877	1290.5	2072.7	3300.5	3.424	3.016	2.373	3
5.500	69.202	1286.4	2077.0	3296.7	3.086	2.691	2.118	3
5.600	69.495	1282.7	2081.0	3293.4	2.780	2.403	1.891	3
5.700	69.759	1279.2	2084.6	3290.4	2.505	2.148	1.691	3
5.800	69.997	1276.1	2087.9	3287.8	2.257	1.921	1.512	3
5.900	70.211	1273.3	2090.9	3285.4	2.034	1.719	1.353	3
6.000	70.405	1270.7	2093.6	3283.3	1.833	1.540	1.212	3

DYNAMIC ANALYSIS

5/10/87

ENERGY RECOVERY ELEVATION - Adiabatic

TIME	ANGLE	EXTEND	RETRACT	EQUIL	ANGULAR	EXTEND	RETRACT	
SEC	DEGREE	PRESS	PRESS	PRESS	VELOCITY	FLOW	FLOW	
		PSIA	PSIA	PSIA	DEG/SEC	GPM	GPM	
6.100	70.579	1268.3	2096.1	3281.4	1.651	1.380	1.086	3
6.200	70.735	1266.2	2098.3	3279.7	1.488	1.237	0.973	3
6.300	70.877	1264.2	2100.4	3278.2	1.341	1.109	0.873	3
6.400	71.004	1262.4	2102.3	3276.8	1.208	0.995	0.783	3
6.500	71.119	1260.8	2103.9	3275.6	1.088	0.893	0.703	3
6.600	71.222	1259.4	2105.5	3274.5	0.981	0.802	0.631	3
6.700	71.315	1258.0	2106.9	3273.6	0.884	0.720	0.567	3
6.800	71.399	1256.8	2108.1	3272.7	0.796	0.647	0.509	3
6.900	71.475	1255.8	2109.3	3271.9	0.717	0.582	0.458	3
7.000	71.543	1254.8	2110.3	3271.2	0.646	0.523	0.412	3
7.100	71.604	1253.9	2111.2	3270.5	0.583	0.470	0.370	3
7.200	71.659	1253.1	2112.1	3270.0	0.525	0.423	0.333	3
7.300	71.709	1252.4	2112.8	3269.5	0.473	0.380	0.299	3
7.400	71.754	1251.7	2113.5	3269.0	0.426	0.342	0.269	3
7.500	71.795	1251.1	2114.1	3268.6	0.384	0.308	0.242	3
7.600	71.831	1250.6	2114.7	3268.2	0.346	0.277	0.218	3
7.700	71.864	1250.1	2115.2	3267.9	0.312	0.249	0.196	3
7.800	71.893	1249.6	2115.7	3267.6	0.281	0.224	0.177	3
7.900	71.920	1249.3	2116.1	3267.3	0.253	0.202	0.159	3
8.000	71.944	1248.9	2116.4	3267.0	0.228	0.182	0.143	3
8.100	71.966	1248.6	2116.8	3266.8	0.205	0.164	0.129	3
8.200	71.985	1248.3	2117.1	3266.6	0.185	0.147	0.116	3
8.300	72.000	1243.2	2122.2	3266.5	0.170	0.000	0.000	3

DYNAMIC ANALYSIS
ENERGY RECOVERY ELEVATION - Adiabatic

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EQUILIBRATION CYLINDER PARAMETERS:

PISTON AREA (2)	IN ²	5.522
EQUILIBRATION ACCUMULATOR VOLUME	IN ³	1200.00
AMBIENT TEMPERATURE	deg-F	160.00
CHARGE PRESSURE AT 70 deg-F	PSIA	2800.00
STARTING PRESSURE AT 0 Q.E.	PSIA	5200.00
OIL VOLUME ADJUSTMENT FROM 70 deg-F	IN ³	-99.39

ELEVATION CYLINDER PARAMETERS:

STARTING DECELERATION PRESSURE	PSIA	3000.000
MAXIMUM DECELERATION TORQUE	FT-LB	10000.000
ENERGY STORE ACCUM GAS VOLUME	IN ³	2400.000
ENERGY STORE ACCUM PRESSURE	PSIA	3000.000
PISTON DIAMETER	INCH	3.250
ROD DIAMETER	INCH	1.500

SYSTEM PARAMETERS:

STARTING ELEVATION (THETA ₀)	DEGREES	0.000
ENDING ELEVATION (THETA _f)	DEGREES	72.000
ELEVATING WEIGHT	LBS	6077.000
MASS MOMENT OF INERTIA (I)	SLUG-FT ²	41230.000

TIME SEC	ANGLE DEGREE	EXTEND PRESS PSIA	RETRACT PRESS PSIA	EQUIL PRESS PSIA	ANGULAR VELOCITY DEG/SEC	EXTEND FLOW GPM	RETRACT FLOW GPM	
0.001	0.000	351.5	3000.0	5200.0	0.022	0.000	0.000	1
0.100	0.223	403.5	2948.3	5192.8	4.395	5.444	4.285	1
0.200	0.863	537.0	2815.4	5172.0	8.247	10.287	8.096	1
0.300	1.845	700.7	2652.5	5140.1	11.231	14.114	11.108	1
0.400	3.080	850.0	2504.3	5100.2	13.302	16.856	13.266	1
0.500	4.481	963.6	2392.0	5055.3	14.604	18.668	14.691	1
0.600	5.982	1040.0	2317.1	5007.5	15.345	19.785	15.571	1
0.700	7.538	1086.8	2271.7	4958.5	15.714	20.431	16.079	1
0.800	9.118	1113.2	2246.9	4909.3	15.856	20.777	16.351	1
0.900	10.705	1126.7	2234.9	4860.3	15.866	20.942	16.481	1
1.000	12.289	1132.6	2230.6	4812.1	15.806	21.000	16.527	1
1.100	13.865	1134.2	2230.7	4764.7	15.712	20.999	16.526	1
1.200	15.430	1133.4	2233.0	4718.3	15.606	20.967	16.501	1
1.300	16.986	1131.6	2236.5	4672.8	15.499	20.920	16.464	1
1.400	18.530	1129.4	2240.3	4628.3	15.399	20.867	16.422	1
1.500	20.066	1127.1	2244.2	4584.8	15.308	20.814	16.380	1
1.600	21.592	1125.0	2248.0	4542.1	15.229	20.762	16.339	1
1.700	23.112	1123.2	2251.5	4500.4	15.163	20.714	16.301	1

DYNAMIC ANALYSIS

5/10/87

ENERGY RECOVERY ELEVATION - Adiabatic

TIME SEC	ANGLE DEGREE	EXTEND PRESS PSIA	RETRACT PRESS PSIA	EQUIL PRESS PSIA	ANGULAR VELOCITY DEG/SEC	EXTEND FLOW GPM	RETRACT FLOW GPM	
1.800	24.625	1121.6	2254.7	4459.6	15.110	20.669	16.266	1
1.900	26.134	1120.4	2257.6	4419.6	15.071	20.629	16.235	1
2.000	27.640	1119.5	2260.1	4380.4	15.045	20.594	16.207	1
2.100	29.144	1119.0	2262.4	4342.1	15.032	20.562	16.182	1
2.200	30.647	1118.7	2264.3	4304.5	15.034	20.535	16.161	1
2.300	32.151	1118.8	2266.0	4267.6	15.049	20.512	16.143	1
2.400	33.657	1119.1	2267.4	4231.5	15.080	20.493	16.127	1
2.500	35.167	1119.7	2268.5	4196.1	15.125	20.477	16.115	1
2.600	36.683	1120.6	2269.4	4161.3	15.186	20.464	16.105	1
2.700	38.205	1121.6	2270.1	4127.3	15.264	20.454	16.097	1
2.800	39.736	1122.9	2270.6	4093.8	15.359	20.447	16.091	1
2.900	41.278	1124.3	2271.0	4061.1	15.472	20.442	16.087	1
3.000	42.831	1125.9	2271.2	4028.9	15.606	20.438	16.085	1
3.100	44.400	1127.5	2271.4	3997.4	15.761	20.436	16.083	1
3.200	45.985	1129.2	2271.6	3966.4	15.940	20.433	16.081	1
3.300	47.589	1130.8	2271.8	3936.1	16.144	20.430	16.078	1
3.400	49.214	1132.3	2272.1	3906.3	16.377	20.426	16.075	1
3.500	50.865	1133.6	2272.7	3877.1	16.641	20.418	16.068	1
3.600	52.544	1134.5	2273.7	3848.5	16.941	20.404	16.058	1
3.700	54.255	1135.0	2275.2	3820.4	17.281	20.383	16.041	1
3.800	55.987	1546.6	1865.4	3793.2	16.859	19.438	15.297	3
3.900	57.588	1531.1	1882.7	3769.0	15.191	17.102	13.459	3
4.000	59.030	1517.1	1898.2	3748.0	13.688	15.053	11.847	3
4.100	60.329	1504.3	1912.3	3729.9	12.333	13.258	10.434	3
4.200	61.500	1492.7	1925.1	3714.1	11.113	11.687	9.197	3
4.300	62.555	1482.1	1936.8	3700.3	10.013	10.310	8.114	3
4.400	63.506	1472.3	1947.5	3688.2	9.023	9.105	7.166	3
4.500	64.363	1463.3	1957.3	3677.7	8.130	8.049	6.335	3
4.600	65.135	1455.1	1966.3	3668.4	7.325	7.124	5.606	3
4.700	65.830	1447.5	1974.6	3660.3	6.600	6.311	4.967	3
4.800	66.457	1440.5	1982.2	3653.1	5.947	5.598	4.405	3
4.900	67.021	1434.0	1989.1	3646.8	5.359	4.970	3.912	3
5.000	67.530	1428.1	1995.5	3641.2	4.829	4.418	3.477	3
5.100	67.989	1422.7	2001.4	3636.2	4.351	3.930	3.093	3
5.200	68.402	1417.7	2006.7	3631.8	3.920	3.500	2.755	3
5.300	68.774	1413.1	2011.6	3627.9	3.532	3.120	2.456	3
5.400	69.109	1408.9	2016.1	3624.4	3.183	2.784	2.191	3
5.500	69.411	1405.0	2020.2	3621.3	2.868	2.485	1.956	3
5.600	69.684	1401.5	2024.0	3618.6	2.584	2.221	1.748	3
5.700	69.929	1398.3	2027.4	3616.1	2.328	1.986	1.563	3
5.800	70.150	1395.4	2030.5	3613.9	2.098	1.777	1.398	3
5.900	70.349	1392.7	2033.4	3612.0	1.890	1.591	1.252	3
6.000	70.529	1390.3	2035.9	3610.2	1.703	1.425	1.122	3

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DYNAMIC ANALYSIS							
ENERGY RECOVERY ELEVATION - Adiabatic							
TIME	ANGLE	EXTEND	RETRACT	EQUIL	ANGULAR	EXTEND	RETRACT
		PRESS	PRESS	PRESS	VELOCITY	FLOW	FLOW
SEC	DEGREE	PSIA	PSIA	PSIA	DEG/SEC	GPM	GPM
6.100	70.690	1388.1	2038.3	3608.6	1.535	1.278	1.005 3
6.200	70.836	1386.1	2040.4	3607.2	1.383	1.146	0.902 3
6.300	70.967	1384.2	2042.4	3606.0	1.246	1.028	0.809 3
6.400	71.086	1382.6	2044.1	3604.9	1.123	0.922	0.726 3
6.500	71.192	1381.1	2045.7	3603.8	1.012	0.828	0.652 3
6.600	71.288	1379.7	2047.1	3602.9	0.912	0.744	0.585 3
6.700	71.375	1378.5	2048.5	3602.1	0.821	0.668	0.526 3
6.800	71.453	1377.3	2049.6	3601.4	0.740	0.600	0.473 3
6.900	71.523	1376.3	2050.7	3600.7	0.667	0.540	0.425 3
7.000	71.586	1375.4	2051.7	3600.1	0.601	0.485	0.382 3
7.100	71.643	1374.6	2052.6	3599.6	0.541	0.436	0.343 3
7.200	71.695	1373.8	2053.3	3599.1	0.488	0.393	0.309 3
7.300	71.741	1373.2	2054.1	3598.7	0.440	0.353	0.278 3
7.400	71.783	1372.6	2054.7	3598.3	0.396	0.318	0.250 3
7.500	71.821	1372.0	2055.3	3598.0	0.357	0.286	0.225 3
7.600	71.854	1371.5	2055.8	3597.7	0.322	0.257	0.202 3
7.700	71.885	1371.0	2056.3	3597.4	0.290	0.232	0.182 3
7.800	71.912	1370.6	2056.7	3597.1	0.261	0.208	0.164 3
7.900	71.937	1370.3	2057.1	3596.9	0.235	0.188	0.148 3
8.000	71.960	1369.9	2057.5	3596.7	0.212	0.169	0.133 3
8.100	71.980	1369.6	2057.8	3596.5	0.191	0.152	0.120 3
8.200	71.998	1369.4	2058.1	3596.3	0.172	0.137	0.108 3
8.300	72.000	1364.5	2063.0	3596.3	0.170	0.000	0.000 3

DYNAMIC ANALYSIS
ENERGY RECOVERY ELEVATION - Adiabatic

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EQUILIBRATION CYLINDER PARAMETERS:

PISTON AREA (2)	IN ²	5.522
EQUILIBRATION ACCUMULATOR VOLUME	IN ³	1200.00
AMBIENT TEMPERATURE	deg-F	-25.00
CHARGE PRESSURE AT 70 deg-F	PSIA	2800.00
STARTING PRESSURE AT 0 Q.E.	PSIA	5200.00
OIL VOLUME ADJUSTMENT FROM 70 deg-F	IN ³	102.15

ELEVATION CYLINDER PARAMETERS:

STARTING DECELERATION PRESSURE	PSIA	3000.000
MAXIMUM DECELERATION TORQUE	FT-LB	10000.000
ENERGY STORE ACCUM GAS VOLUME	IN ³	2400.000
ENERGY STORE ACCUM PRESSURE	PSIA	3000.000
PISTON DIAMETER	INCH	3.250
ROD DIAMETER	INCH	1.500

SYSTEM PARAMETERS:

STARTING ELEVATION (THETA _o)	DEGREES	0.000
ENDING ELEVATION (THETA _f)	DEGREES	72.000
ELEVATING WEIGHT	LBS	6077.000
MASS MOMENT OF INERTIA (I)	SLUG-FT ²	41230.000

TIME SEC	ANGLE DEGREE	EXTEND PRESS PSIA	RETRACT PRESS PSIA	EQUIL PRESS PSIA	ANGULAR VELOCITY DEG/SEC	EXTEND FLOW GPM	RETRACT FLOW GPM	
0.001	0.000	246.7	3000.0	5200.0	0.024	0.000	0.000	1
0.100	0.240	306.2	2940.6	5186.3	4.709	5.834	4.591	1
0.200	0.922	456.5	2790.8	5147.3	8.775	10.951	8.618	1
0.300	1.962	634.3	2613.5	5088.4	11.834	14.883	11.713	1
0.400	3.256	788.2	2460.6	5016.2	13.861	17.584	13.838	1
0.500	4.707	896.9	2352.8	4936.6	15.048	19.261	15.158	1
0.600	6.246	962.6	2288.1	4853.8	15.643	20.200	15.897	1
0.700	7.824	996.0	2255.7	4770.7	15.862	20.655	16.255	1
0.800	9.411	1008.6	2244.3	4689.0	15.860	20.813	16.379	1
0.900	10.992	1008.7	2245.3	4609.4	15.738	20.799	16.368	1
1.000	12.557	1001.9	2253.1	4532.5	15.556	20.691	16.283	1
1.100	14.102	991.9	2264.3	4458.3	15.351	20.535	16.161	1
1.200	15.627	980.4	2276.8	4386.9	15.143	20.360	16.023	1
1.300	17.131	968.7	2289.7	4318.1	14.943	20.178	15.880	1
1.400	18.616	957.3	2302.1	4251.8	14.756	20.001	15.740	1
1.500	20.083	946.6	2313.9	4187.9	14.584	19.831	15.606	1
1.600	21.533	936.7	2325.0	4126.3	14.430	19.671	15.480	1
1.700	22.969	927.6	2335.2	4066.8	14.293	19.521	15.363	1

DYNAMIC ANALYSIS								5/10/87
ENERGY RECOVERY ELEVATION - Adiabatic								
TIME	ANGLE	EXTEND	RETRACT	EQUIL	ANGULAR	EXTEND	RETRACT	
SEC	DEGREE	PRESS	PRESS	PRESS	VELOCITY	FLOW	FLOW	
		PSIA	PSIA	PSIA	DEG/SEC	GPM	GPM	
1.800	24.392	919.3	2344.5	4009.3	14.172	19.383	15.254	1
1.900	25.804	911.8	2353.1	3953.7	14.069	19.256	15.154	1
2.000	27.206	905.1	2360.9	3899.9	13.981	19.140	15.063	1
2.100	28.601	899.2	2368.0	3847.8	13.910	19.034	14.979	1
2.200	29.989	893.9	2374.3	3797.2	13.854	18.937	14.903	1
2.300	31.372	889.3	2380.1	3748.2	13.813	18.851	14.835	1
2.400	32.752	885.3	2385.2	3700.6	13.788	18.773	14.774	1
2.500	34.130	881.8	2389.7	3654.4	13.778	18.703	14.719	1
2.600	35.508	879.0	2393.7	3609.4	13.783	18.642	14.671	1
2.700	36.887	876.6	2397.2	3565.7	13.804	18.589	14.629	1
2.800	38.269	874.7	2400.2	3523.0	13.840	18.542	14.592	1
2.900	39.656	873.3	2402.7	3481.7	13.893	18.503	14.561	1
3.000	41.049	872.3	2404.9	3441.3	13.963	18.469	14.535	1
3.100	42.449	871.6	2406.7	3401.8	14.049	18.442	14.513	1
3.200	43.859	871.3	2408.1	3363.2	14.155	18.419	14.495	1
3.300	45.281	871.3	2409.3	3325.5	14.279	18.401	14.481	1
3.400	46.716	871.5	2410.2	3288.7	14.425	18.386	14.470	1
3.500	48.166	871.9	2411.0	3252.6	14.592	18.375	14.460	1
3.600	49.635	872.5	2411.6	3217.4	14.784	18.365	14.453	1
3.700	51.124	873.1	2412.2	3182.9	15.002	18.356	14.446	1
3.800	52.637	873.7	2412.8	3149.1	15.249	18.347	14.438	1
3.900	54.175	874.2	2413.5	3116.1	15.529	18.335	14.429	1
4.000	55.744	874.3	2414.6	3083.9	15.845	18.319	14.417	1
4.100	57.332	1259.7	2030.4	3052.6	15.458	17.471	13.749	3
4.200	58.799	1245.0	2046.2	3024.9	13.928	15.377	12.101	3
4.300	60.122	1231.7	2060.4	3000.9	12.550	13.542	10.657	3
4.400	61.313	1219.7	2073.3	2980.2	11.308	11.935	9.392	3
4.500	62.387	1208.7	2085.0	2962.1	10.189	10.528	8.285	3
4.600	63.354	1198.7	2095.7	2946.4	9.181	9.295	7.315	3
4.700	64.226	1189.5	2105.5	2932.6	8.272	8.216	6.466	3
4.800	65.011	1181.1	2114.5	2920.6	7.454	7.270	5.721	3
4.900	65.719	1173.4	2122.7	2910.0	6.716	6.440	5.068	3
5.000	66.357	1166.3	2130.2	2900.7	6.052	5.711	4.494	3
5.100	66.931	1159.7	2137.1	2892.5	5.453	5.070	3.990	3
5.200	67.449	1153.7	2143.4	2885.3	4.913	4.505	3.545	3
5.300	67.915	1148.2	2149.2	2878.9	4.427	4.008	3.154	3
5.400	68.336	1143.2	2154.6	2873.2	3.989	3.568	2.808	3
5.500	68.714	1138.5	2159.4	2868.2	3.594	3.180	2.503	3
5.600	69.056	1134.3	2163.9	2863.7	3.239	2.837	2.233	3
5.700	69.363	1130.4	2168.0	2859.7	2.918	2.533	1.993	3
5.800	69.640	1126.8	2171.7	2856.2	2.629	2.263	1.781	3
5.900	69.890	1123.6	2175.1	2853.0	2.369	2.023	1.592	3
6.000	70.115	1120.6	2178.2	2850.2	2.135	1.810	1.425	3

DYNAMIC ANALYSIS

5/10/87

ENERGY RECOVERY ELEVATION - Adiabatic							
TIME	ANGLE	EXTEND	RETRACT	EQUIL	ANGULAR	EXTEND	RETRACT
SEC	DEGREE	PRESS	PRESS	PRESS	VELOCITY	FLOW	FLOW
		PSIA	PSIA	PSIA	DEG/SEC	GPM	GPM
6.100	70.317	1117.9	2181.0	2847.7	1.924	1.621	1.275 3
6.200	70.500	1115.5	2183.6	2845.5	1.733	1.452	1.142 3
6.300	70.665	1113.2	2185.9	2843.4	1.562	1.301	1.024 3
6.400	70.813	1111.2	2188.0	2841.6	1.407	1.167	0.918 3
6.500	70.946	1109.3	2189.9	2840.0	1.268	1.047	0.824 3
6.600	71.067	1107.7	2191.7	2838.6	1.142	0.939	0.739 3
6.700	71.175	1106.1	2193.3	2837.3	1.029	0.843	0.664 3
6.800	71.273	1104.8	2194.7	2836.1	0.928	0.757	0.596 3
6.900	71.361	1103.5	2196.0	2835.1	0.836	0.680	0.535 3
7.000	71.440	1102.4	2197.2	2834.2	0.753	0.611	0.481 3
7.100	71.512	1101.4	2198.3	2833.3	0.679	0.549	0.432 3
7.200	71.576	1100.4	2199.2	2832.6	0.611	0.494	0.389 3
7.300	71.634	1099.6	2200.1	2831.9	0.551	0.444	0.350 3
7.400	71.687	1098.8	2200.9	2831.3	0.496	0.400	0.314 3
7.500	71.734	1098.1	2201.6	2830.7	0.447	0.359	0.283 3
7.600	71.776	1097.5	2202.2	2830.2	0.403	0.323	0.254 3
7.700	71.815	1097.0	2202.8	2829.8	0.363	0.291	0.229 3
7.800	71.849	1096.5	2203.3	2829.4	0.327	0.262	0.206 3
7.900	71.880	1096.0	2203.8	2829.0	0.295	0.236	0.185 3
8.000	71.908	1095.6	2204.2	2828.7	0.266	0.212	0.167 3
8.100	71.933	1095.2	2204.6	2828.4	0.239	0.191	0.150 3
8.200	71.956	1094.9	2205.0	2828.1	0.216	0.172	0.135 3
8.300	71.976	1094.6	2205.3	2827.9	0.194	0.155	0.122 3
8.400	71.995	1094.3	2205.6	2827.7	0.175	0.139	0.110 3
8.500	72.000	1089.4	2210.5	2827.6	0.170	0.000	0.000 3

DESCRIPTION: EQUILIBRATION ACTUATOR - LEFT

STATUS - PER YORK:

The assembly drawing was nearing completion and the stress analysis was begun. This component has been identified by YII as a long lead item and the design was scheduled for fabrication process review and assembly tooling design. This component was well within its weight budget after Kevlar wrapping of the actuator cylinder was incorporated.

[illegible]

NOTES:

- [illegible]

DESCRIPTION: EQUILIBRATION ACTUATOR - LEFT (Obsolete)

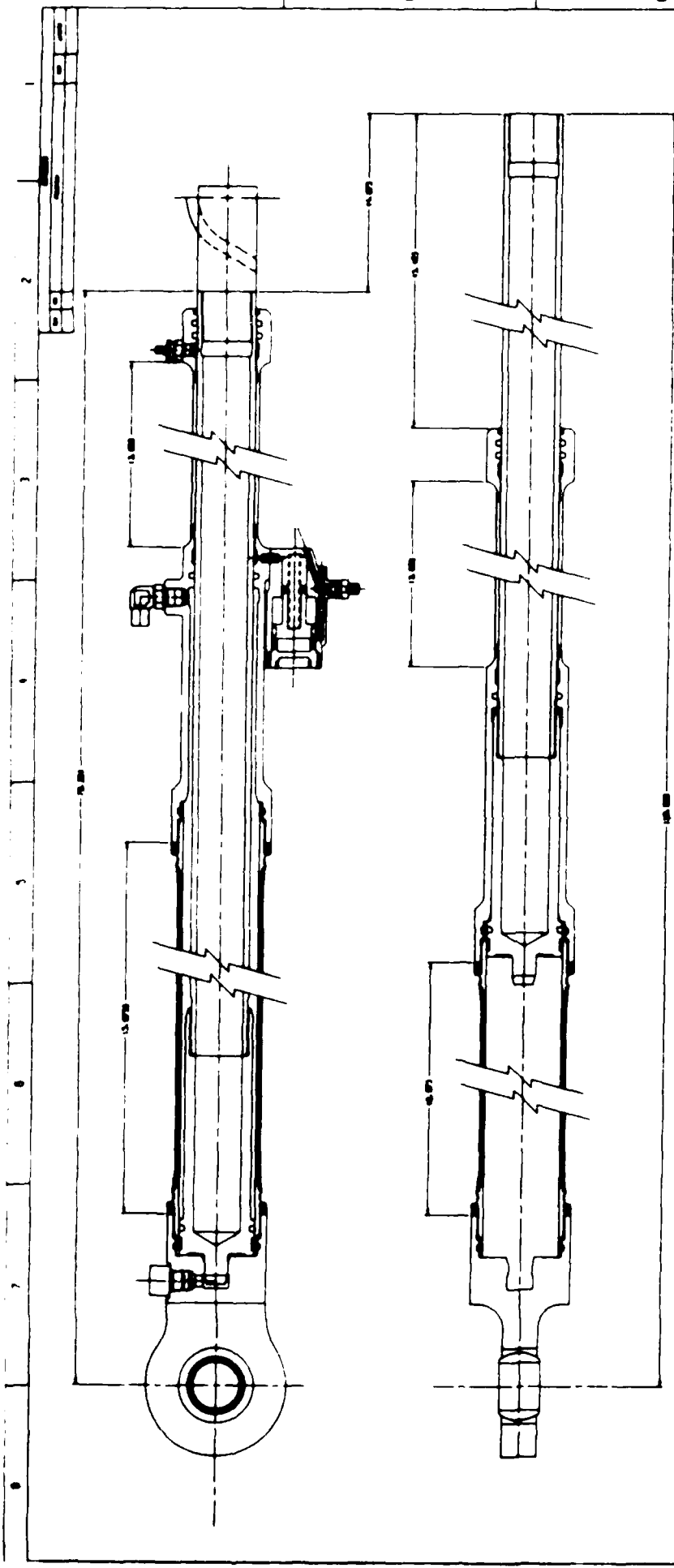
E/191

DESCRIPTION: EQUILIBRATION ACTIVATOR- LEFT (OBSOLETE)

~~STATUS:~~

~~DATE:~~

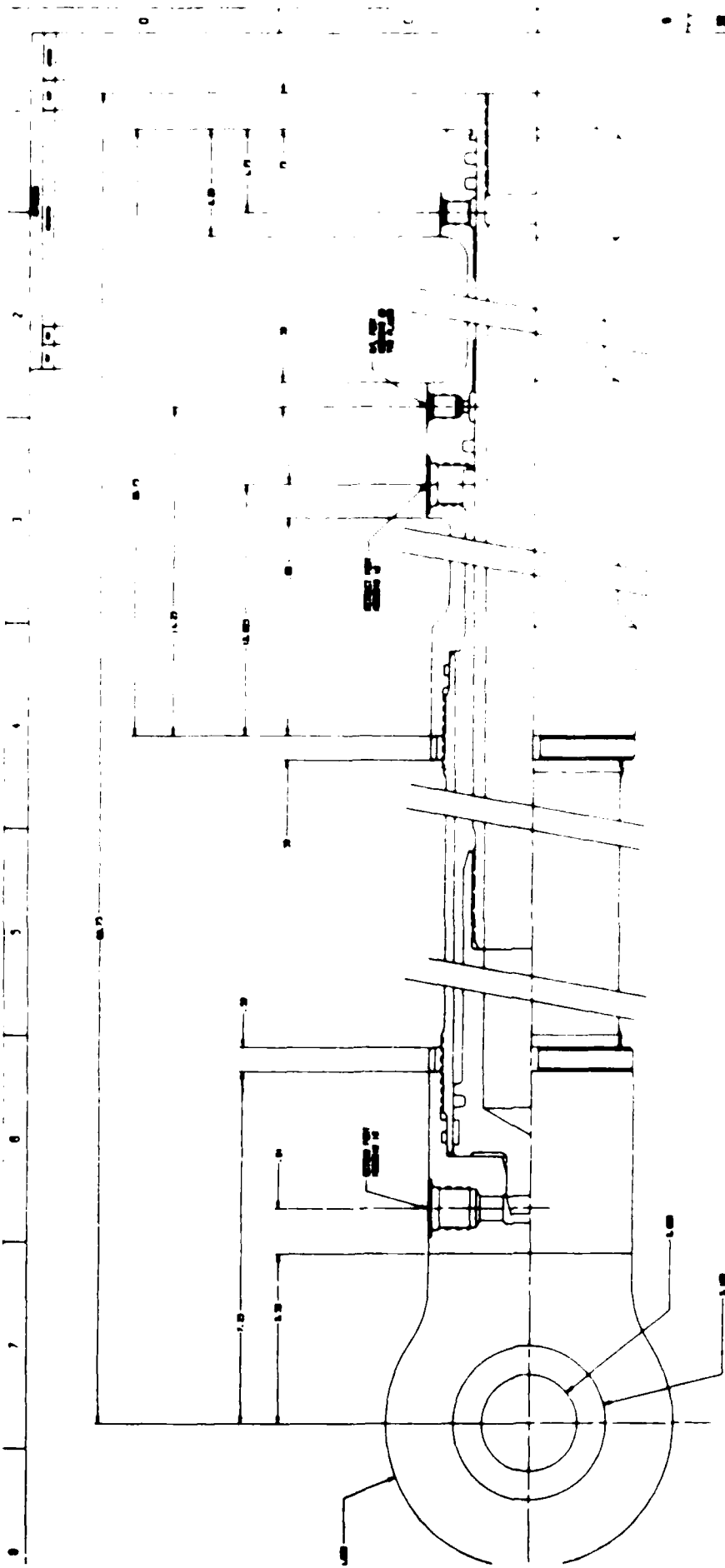
01 64356



NOTES:

1. EXAMINE DRAWING FOR DIMENSIONS AND TOLERANCES.
2. EXAMINE DRAWING FOR MATERIALS AND FINISHES.
3. EXAMINE DRAWING FOR ASSEMBLY INSTRUCTIONS.
4. EXAMINE DRAWING FOR TESTING INSTRUCTIONS.
5. EXAMINE DRAWING FOR PACKAGING INSTRUCTIONS.

YORK INDUSTRIES INC.	
ACTUATOR BEAR-LUC	
COMPLIMENT	
P/N 1-120 57120 8 1-120 57120	
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E/200

DESCRIPTION: EQUILIBRATION ACTUATOR - RIGHT

STATUS: See E/190

DESCRIPTION: LANYARD ACTUATOR

STATUS - PER YORK:

The concept drawing on this actuator was approximately 90% complete. The first review of the design was in progress at the time of contract termination. Although the weight analysis of this actuator had not been updated for the then current design, its estimated weight was near its weight budget and no further weight reduction was anticipated.

E/211

DESCRIPTION: LANYARD ACTUATOR (Obsolete)

AD-A183 995

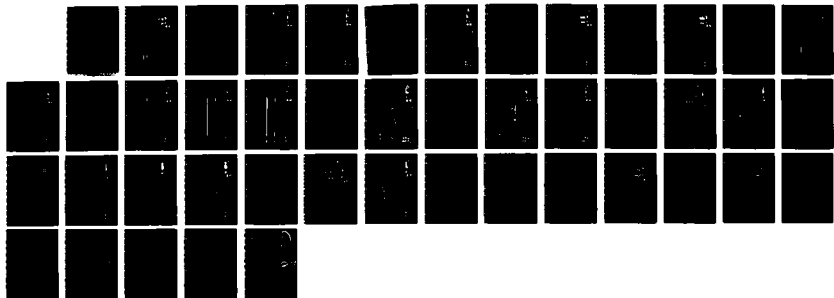
LIGHTWEIGHT TOWED HOWITZER DEMONSTRATOR PHASE 1 AND
PARTIAL PHASE 2 VOLUM (U) FMC CORP MINNEAPOLIS MINN
NORTHERN ORDNANCE DIV R RATHE ET AL APR 87
FMC-E-3041-VOL-E DAAA21-86-C-0047

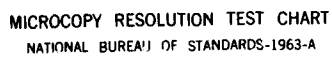
2/2

UNCLASSIFIED

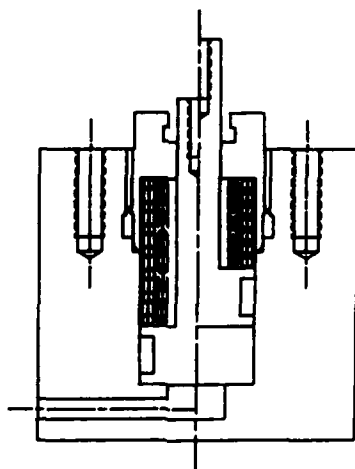
F/G 19/6

NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

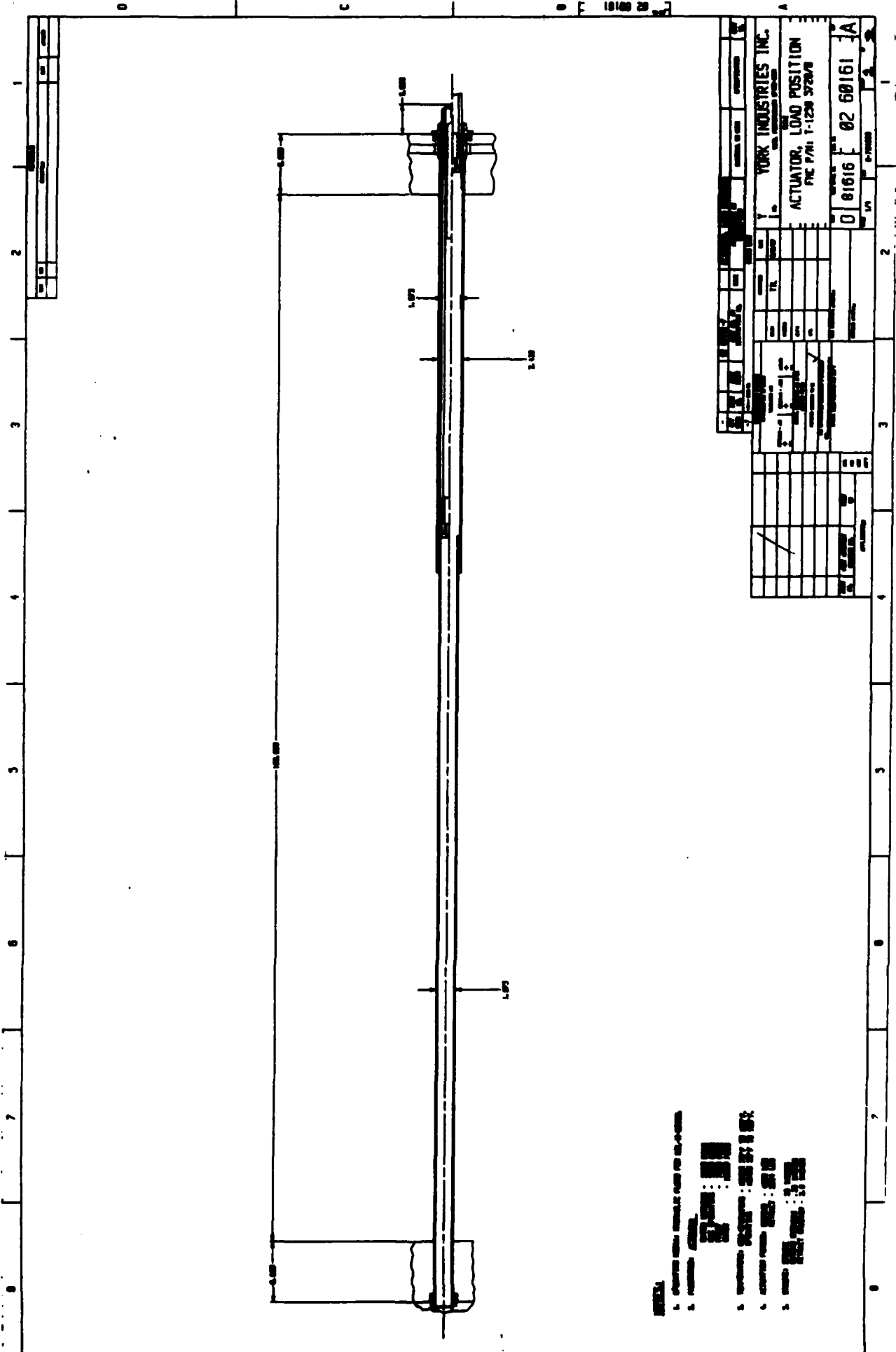


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<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td colspan="2" rowspan="2" style="text-align: center; vertical-align: middle;"> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> </div> <div style="text-align: center;"> </div> </div> </td> <td colspan="2" style="text-align: center;"> YORK INDUSTRIES INC. <small>EST. 1960</small> </td> <td colspan="2" style="text-align: center;"> ACTUATOR LANYARD <small>1-1250 3727A</small> </td> <td colspan="2" style="text-align: center;"> 0 81616 02 60159 </td> <td colspan="2" style="text-align: center;"> <small>0 81616 0 70000</small> </td> </tr> <tr> <td colspan="2" style="text-align: center;"> <small>YORK INDUSTRIES INC.</small> </td> <td colspan="2" style="text-align: center;"> <small>ACTUATOR LANYARD</small> </td> <td colspan="2" style="text-align: center;"> <small>0 81616 0 70000</small> </td> <td colspan="2" style="text-align: center;"> <small>0 81616 0 70000</small> </td> </tr> </table>										<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> </div> <div style="text-align: center;"> </div> </div>		YORK INDUSTRIES INC. <small>EST. 1960</small>		ACTUATOR LANYARD <small>1-1250 3727A</small>		0 81616 02 60159		<small>0 81616 0 70000</small>		<small>YORK INDUSTRIES INC.</small>		<small>ACTUATOR LANYARD</small>		<small>0 81616 0 70000</small>		<small>0 81616 0 70000</small>			
<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> </div> <div style="text-align: center;"> </div> </div>		YORK INDUSTRIES INC. <small>EST. 1960</small>		ACTUATOR LANYARD <small>1-1250 3727A</small>		0 81616 02 60159		<small>0 81616 0 70000</small>																					
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<small>YORK INDUSTRIES INC.</small>		<small>ACTUATOR LANYARD</small>		<small>0 81616 0 70000</small>		<small>0 81616 0 70000</small>		<small>0 81616 0 70000</small>																					

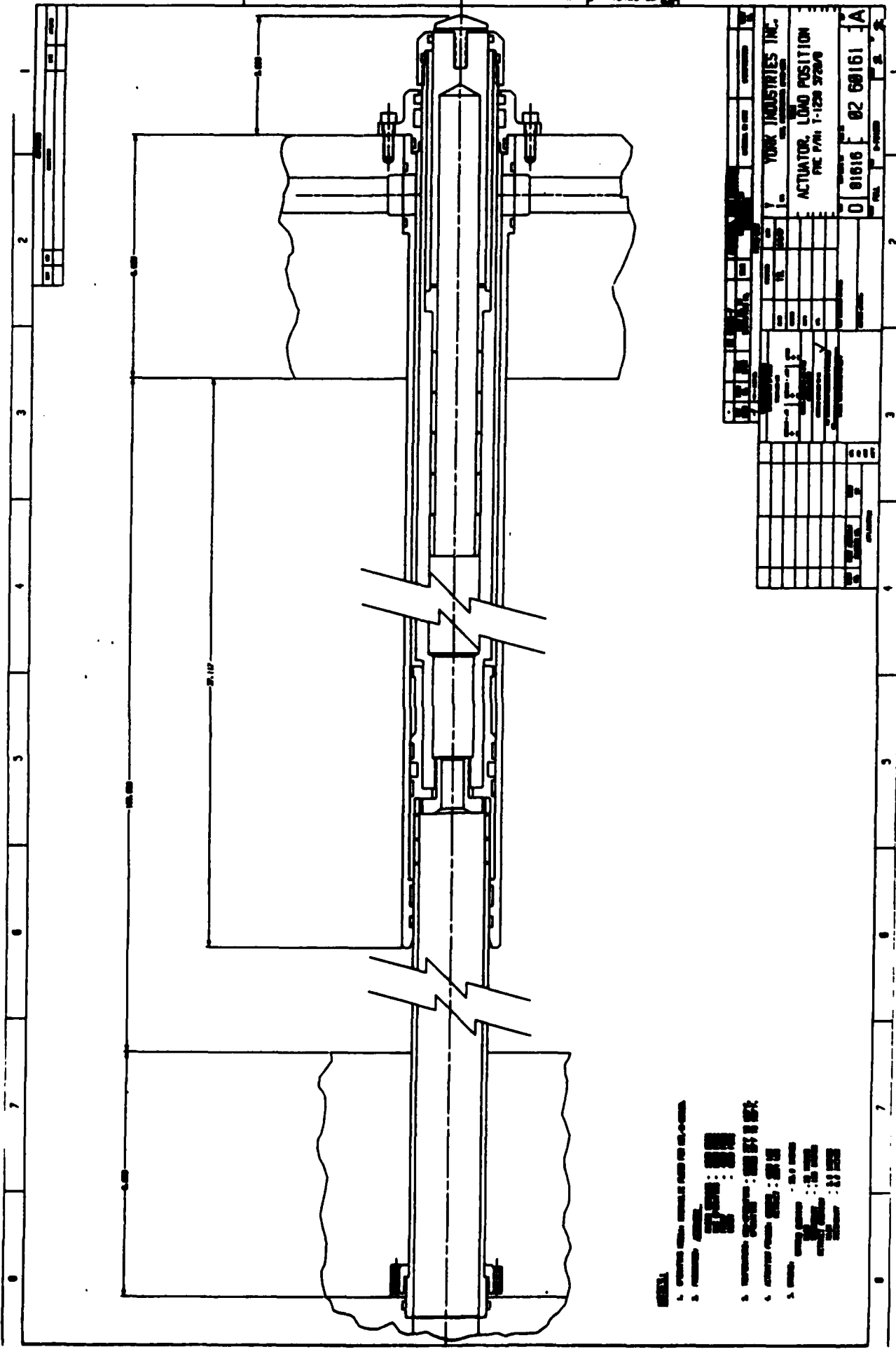
DESCRIPTION: LATCH POSITION ACTUATOR

STATUS - PER YORK:

The concept drawing for the load position actuator was complete and the design was in the process of a fabricability review at the time of contract termination. Although the weight analysis of this actuator had not been updated for the then current design, its estimated weight was near its weight budget and no further weight reduction was anticipated.



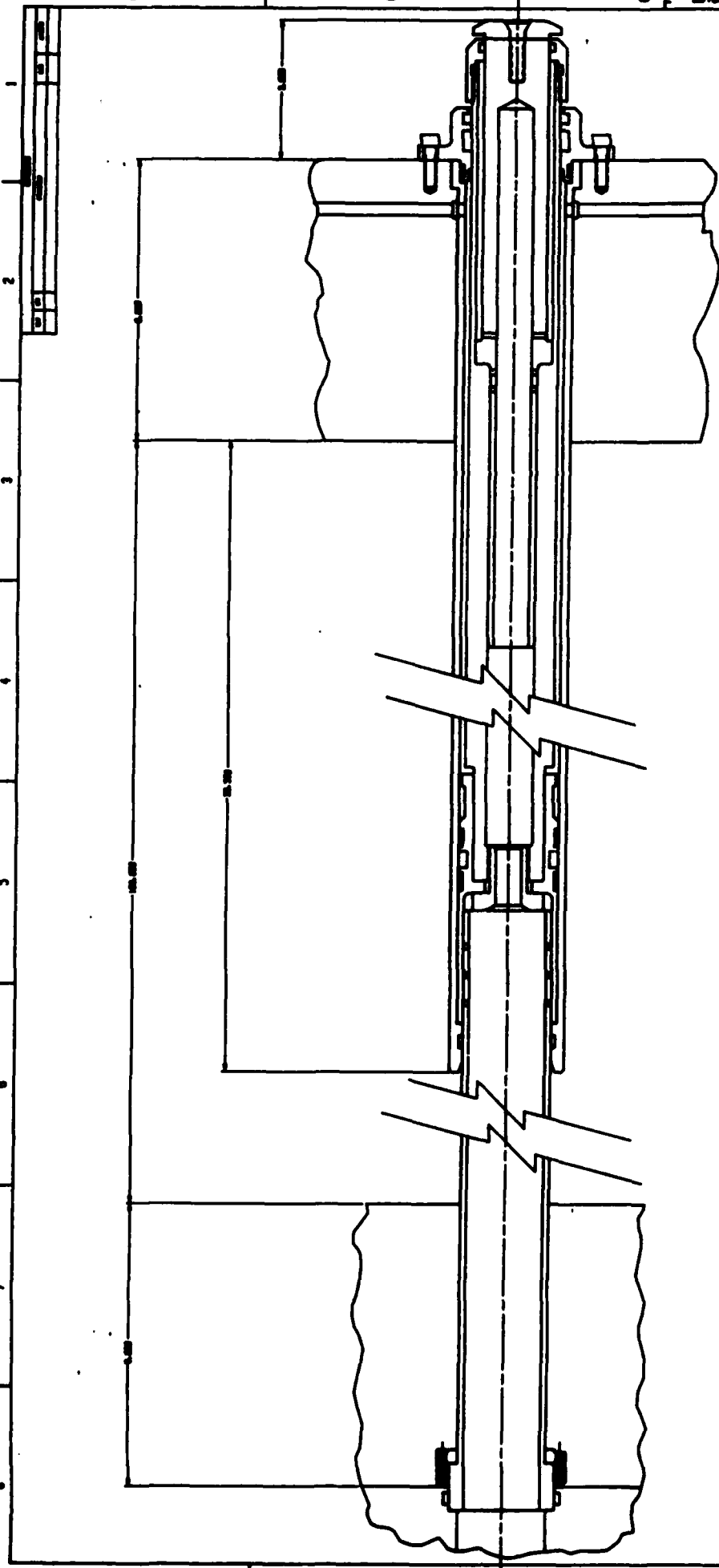
1. CHECKED BY: [Signature]
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1. 1-120 3720
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E/221

DESCRIPTION: LATCH POSITION ACTUATOR (Obsolete)



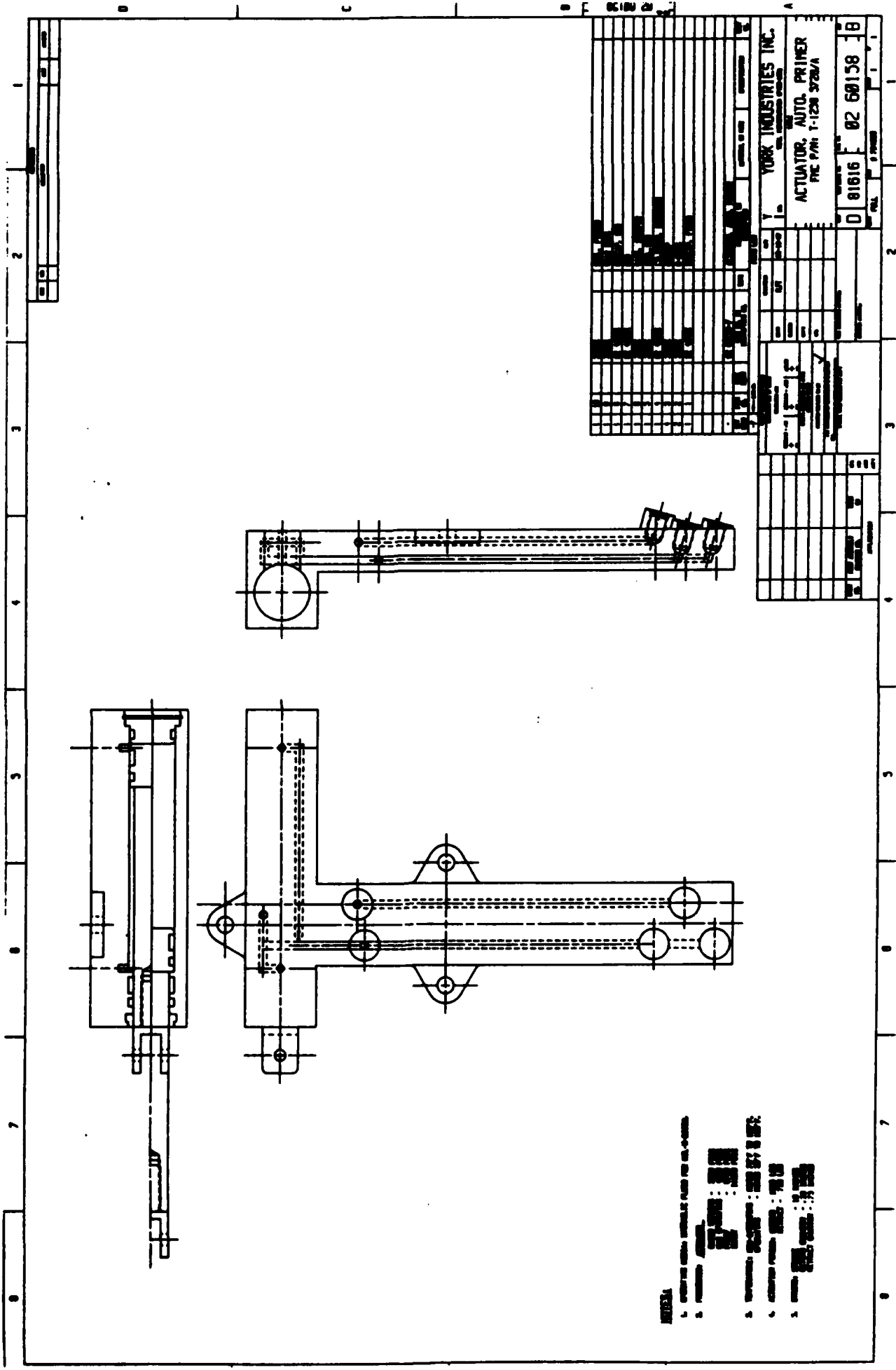
YORK INDUSTRIES INC.	
ACTUATOR, LOAD POSITION	
P/N 7-1230 3720/8	
0 81618	02 68161

1. DRAWING NO. 7-1230 3720/8
 2. REV. 1
 3. DATE 10/10/80
 4. BY J. J. J.
 5. CHECKED BY J. J. J.
 6. APPROVED BY J. J. J.
 7. DATE 10/10/80

DESCRIPTION: PRIMER ACTUATOR**STATUS - PER YORK:**

The concept drawing on this actuator was approximately 80% complete. Design provisions for extensive flexing of its mount and adjacent components were being evaluated. The weight of this unit exceeds its budget due to the extensive manifold incorporated into its requirements. Since there is little expectation of being able to reduce its weight to the budget level, it was recommended that its weight budget be approximately revised.

P

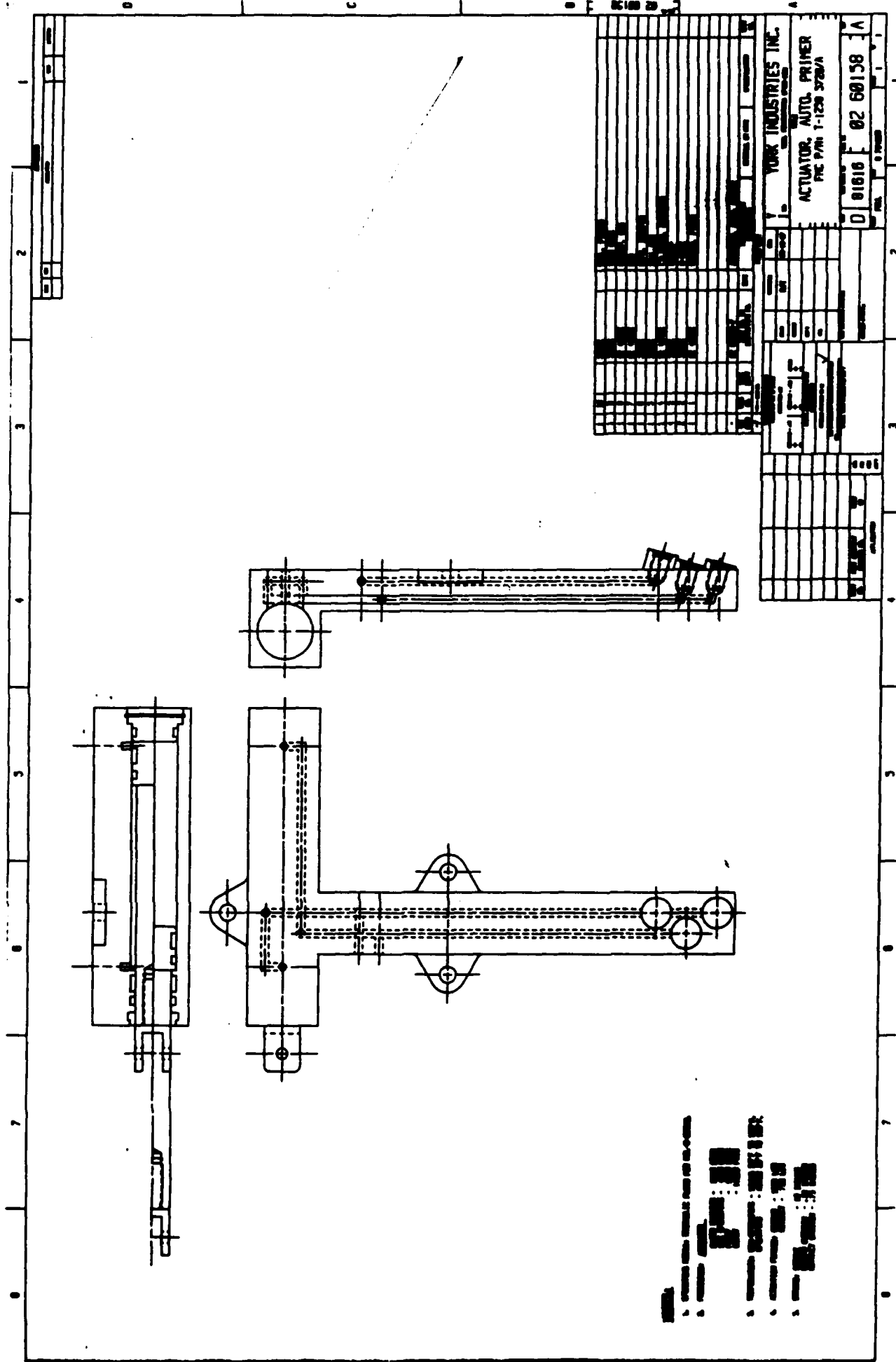


1. ACTUATOR BODY: 1.1250 3/2" DIA.
 2. ACTUATOR ROD: 1.1250 3/2" DIA.
 3. ACTUATOR PISTON: 1.1250 3/2" DIA.
 4. ACTUATOR SEAL: 1.1250 3/2" DIA.
 5. ACTUATOR BUSH: 1.1250 3/2" DIA.

YORK INDUSTRIES INC.	
ACTUATOR, AUTO. PRIMER	
P/N: 1-1250 3/2" DIA.	
Q 81616	02 60158

E/231

DESCRIPTION: PRIMER ACTUATOR (Obsolete)



ITEM NO.	DESCRIPTION	QTY	UNIT
1	BARREL	1	EA
2	BREECH	1	EA
3	TRIGGER MECHANISM	1	EA
4	SAFETY MECHANISM	1	EA
5	RECOIL SPRING	1	EA
6	TRIGGER GUARD	1	EA
7	SAFETY LEVER	1	EA
8	TRIGGER PULLER	1	EA
9	SAFETY PIN	1	EA
10	TRIGGER SPRING	1	EA
11	SAFETY SPRING	1	EA
12	TRIGGER PIN	1	EA
13	SAFETY PIN	1	EA
14	TRIGGER PIN	1	EA
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16	TRIGGER PIN	1	EA
17	SAFETY PIN	1	EA
18	TRIGGER PIN	1	EA
19	SAFETY PIN	1	EA
20	TRIGGER PIN	1	EA

YORK INDUSTRIES INC.	
ACTUATOR, AUTO. PRIMER	
P/N 1-129 3720/A	
D 01010	02 60158 1A

1. DRAWING NO. 1-129 3720/A
 2. REV. 1
 3. DATE 10-1-60
 4. BY J. H. B. / J. H. B.
 5. CHECKED BY J. H. B. / J. H. B.
 6. APPROVED BY J. H. B. / J. H. B.

DESCRIPTION: RAMMER ACTUATOR

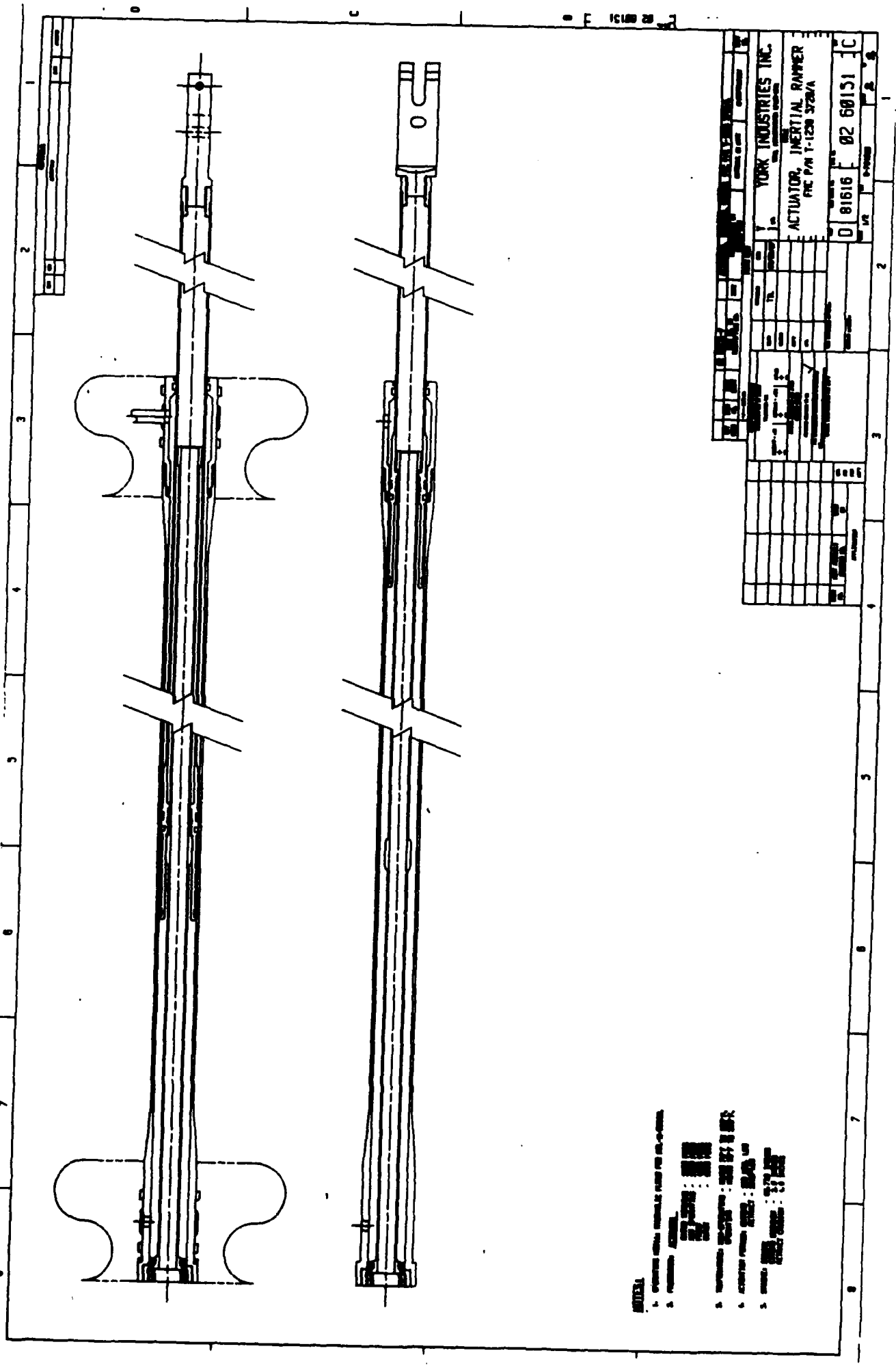
STATUS - PER YORK:

The concept drawing on this actuator was completed and the assembly drawing begun. An internal design review of fabricability and assembly potential problems was in progress. The design of this actuator permits extensive flexing in its mounts and possible problems were being evaluated. The weight of this unit exceeds its budget; therefore, further weight reduction effort is anticipated.

STATUS - PER FMC:

Rod size was determined by 18-20 g LAPES - load (calculations by Jeff Ireland).

AUTHOR: Jeff Ireland/Bart Anderson

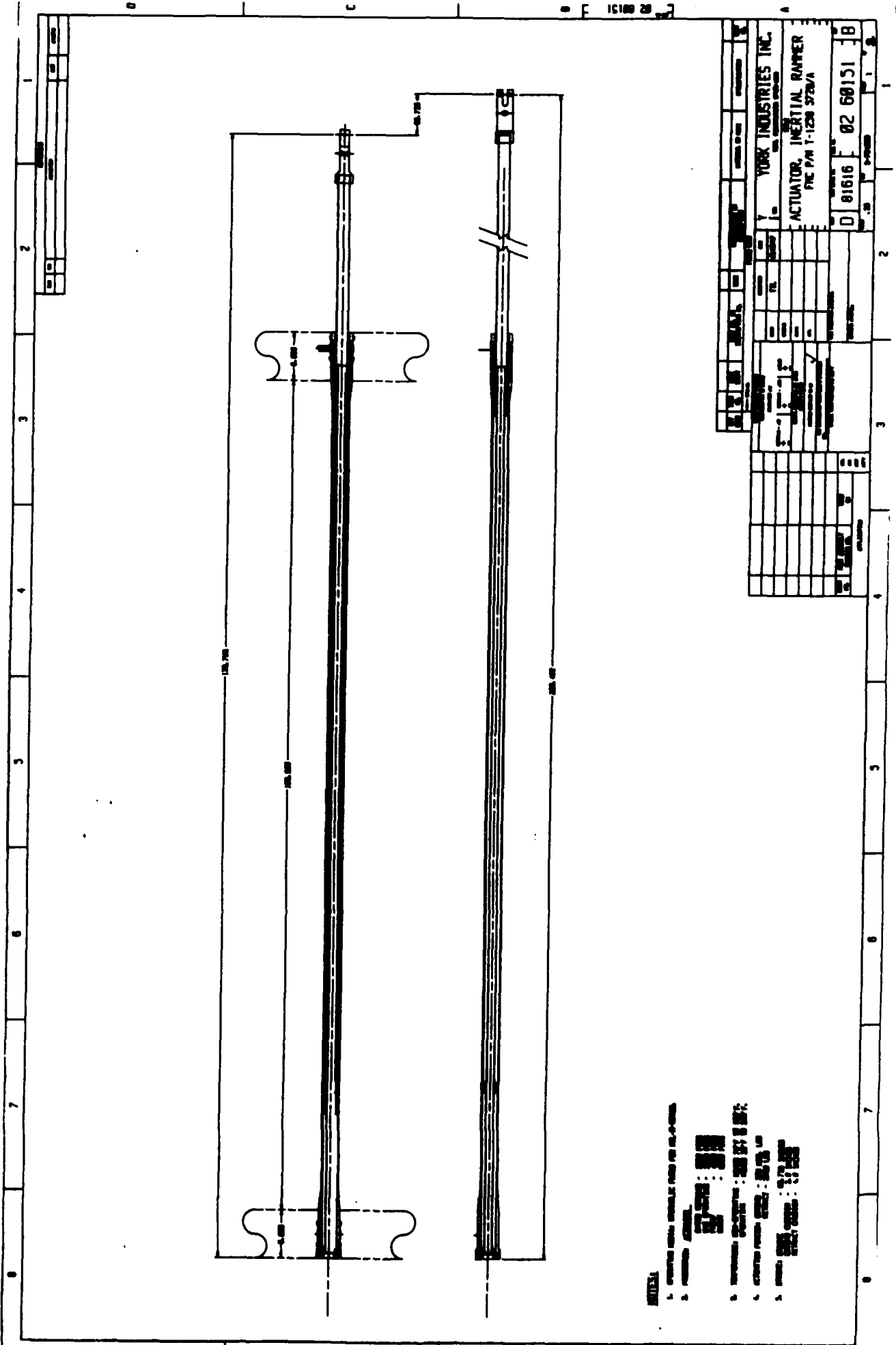


YORK INDUSTRIES INC.	
ACTUATOR, INERTIAL RAMMER	
P/N T-1238 372A	
Q 81616	Q2 60151

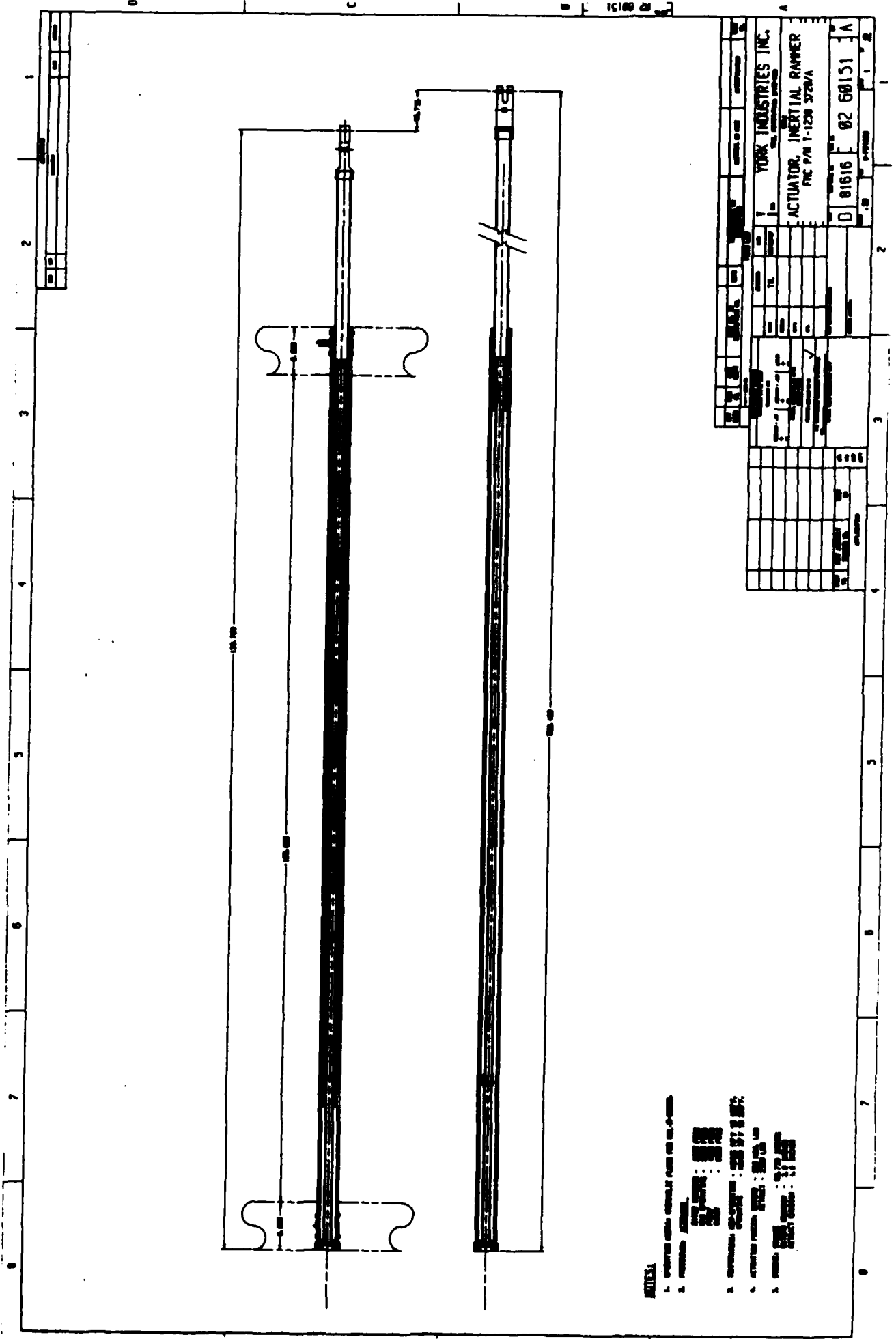
- NOTES:
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E/241

DESCRIPTION: RAMMER ACTUATOR (Obsolete)

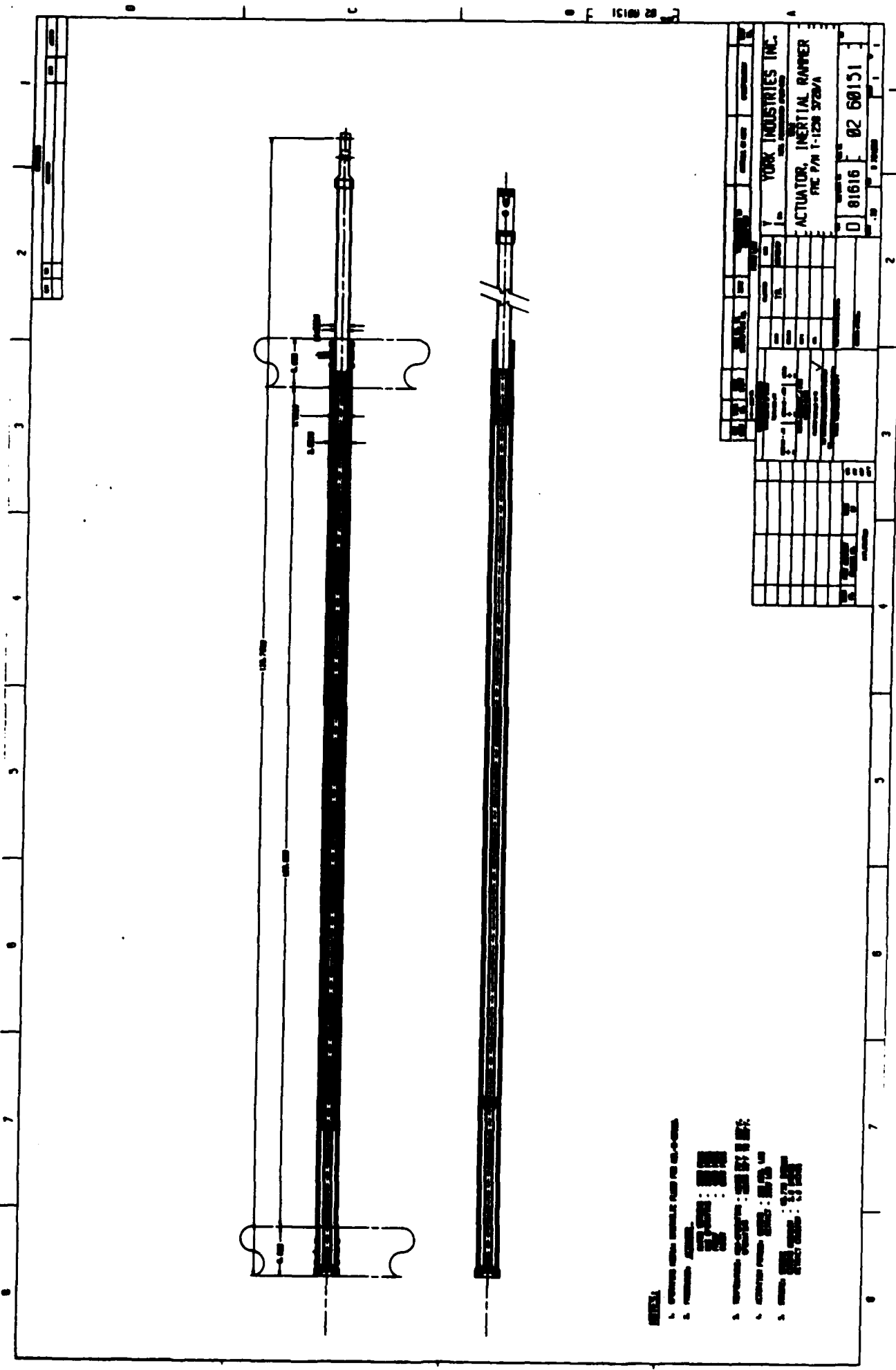


REVISIONS
1. REVISED: 02-07-70 BY: 10100 28
2. REVISED: 02-07-70 BY: 10100 28
3. REVISED: 02-07-70 BY: 10100 28
4. REVISED: 02-07-70 BY: 10100 28
5. REVISED: 02-07-70 BY: 10100 28



YORK INDUSTRIES INC.	
ACTUATOR, INERTIAL RAMPER	
P/N 1-125 3720/A	
Q 81616	02 60151
A	

1. OPERATING WEIGHT: 100 LBS
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 4. OPERATING WEIGHT: 100 LBS
 5. OPERATING WEIGHT: 100 LBS



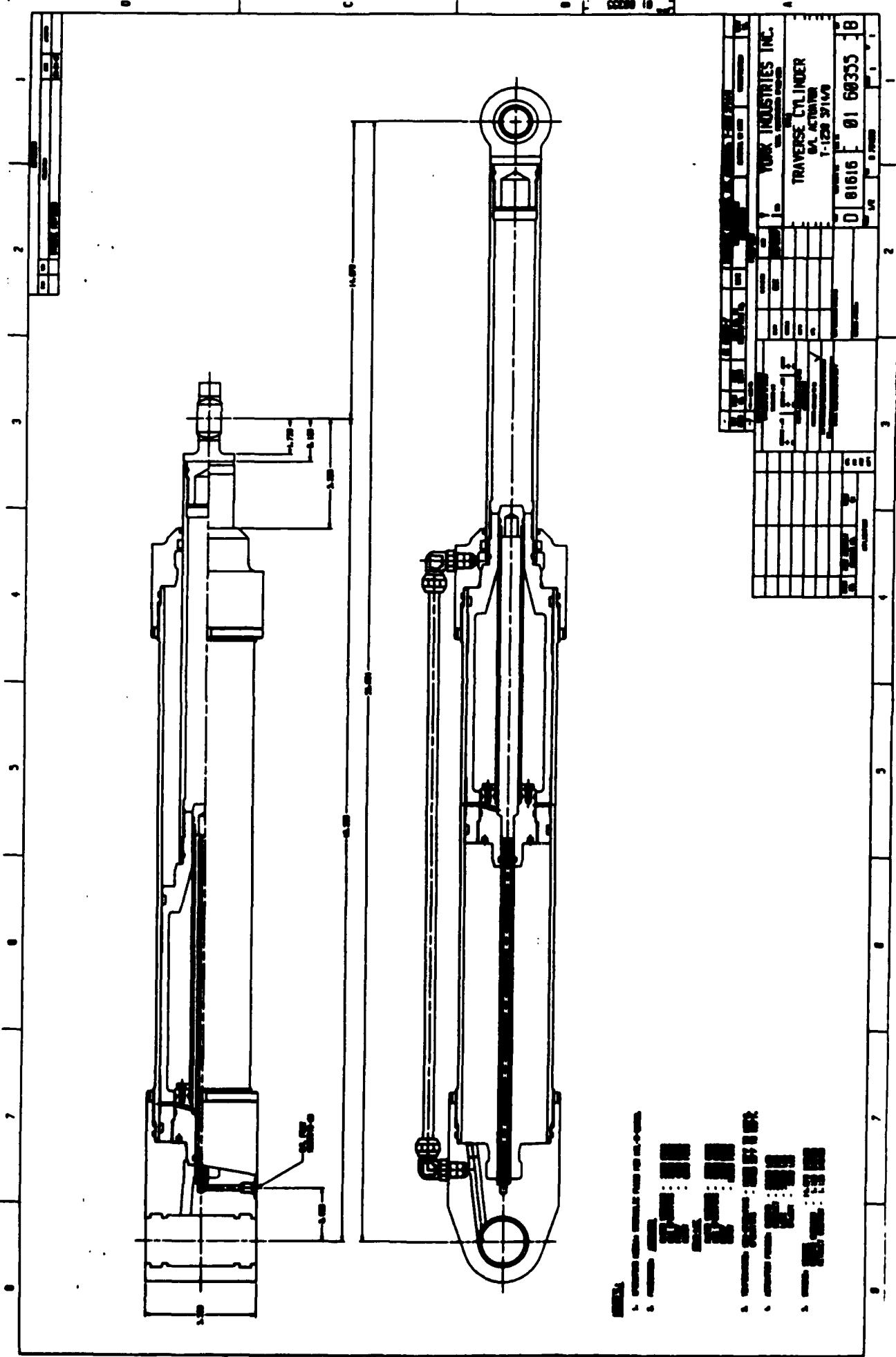
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 3. APPROVED FOR RELEASE BY NSA/CSS
 4. APPROVED FOR RELEASE BY NSA/CSS
 5. APPROVED FOR RELEASE BY NSA/CSS

YORK INDUSTRIES INC.	
ACTUATOR, INERTIAL RUNNER	
P/N 1-128 572/A	
Q 81616	02 60151

DESCRIPTION: TRAVERSE ACTUATOR

STATUS - PER YORK:

The concept drawing is complete, but the stroke must be changed to the requirements of the March 6 coordination meeting. The projected weight estimate is over the allotted target weight due to the increase in stroke, thus another weight reduction pass would have been required.



YORK INDUSTRIES INC.	
TRAVERSE CYLINDER	
VAL. ACTUATOR	
T-1220 37147	
D 81616	01 68355
B	

1. DRAWING MADE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

2. DRAWING MADE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

3. DRAWING MADE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

4. DRAWING MADE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

5. DRAWING MADE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

6. DRAWING MADE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

7. DRAWING MADE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

8. DRAWING MADE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

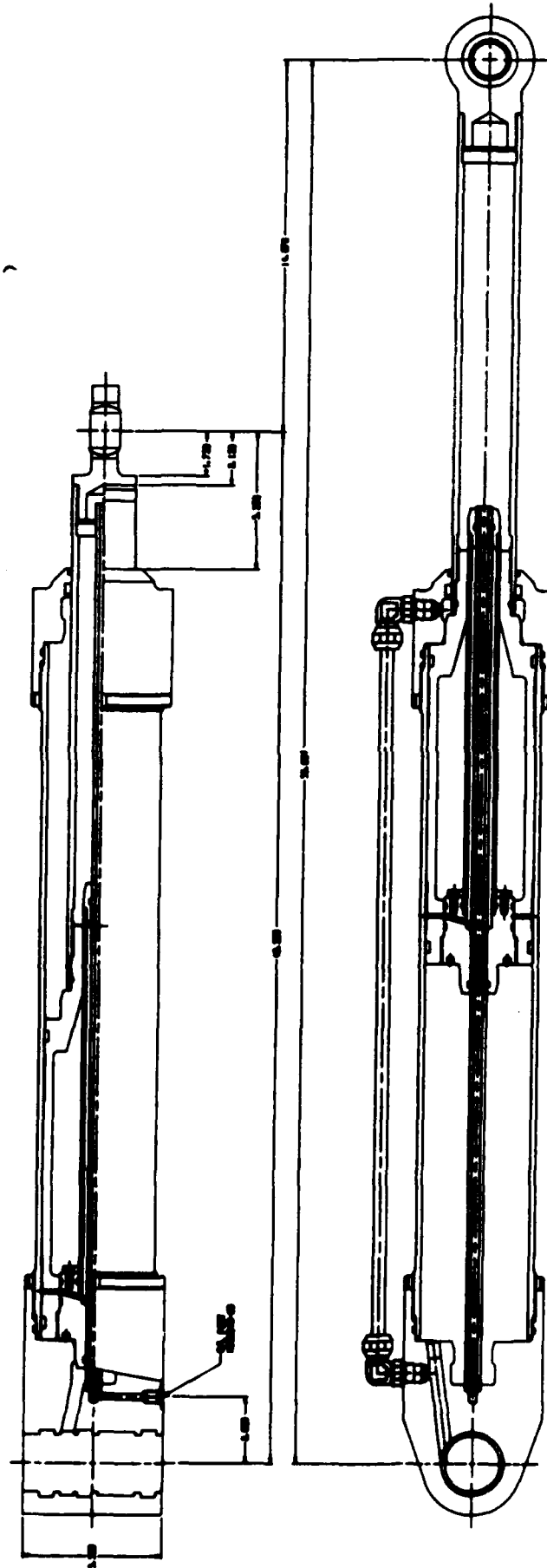
9. DRAWING MADE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

10. DRAWING MADE IN ACCORDANCE WITH THE FOLLOWING SPECIFICATIONS:

E/251

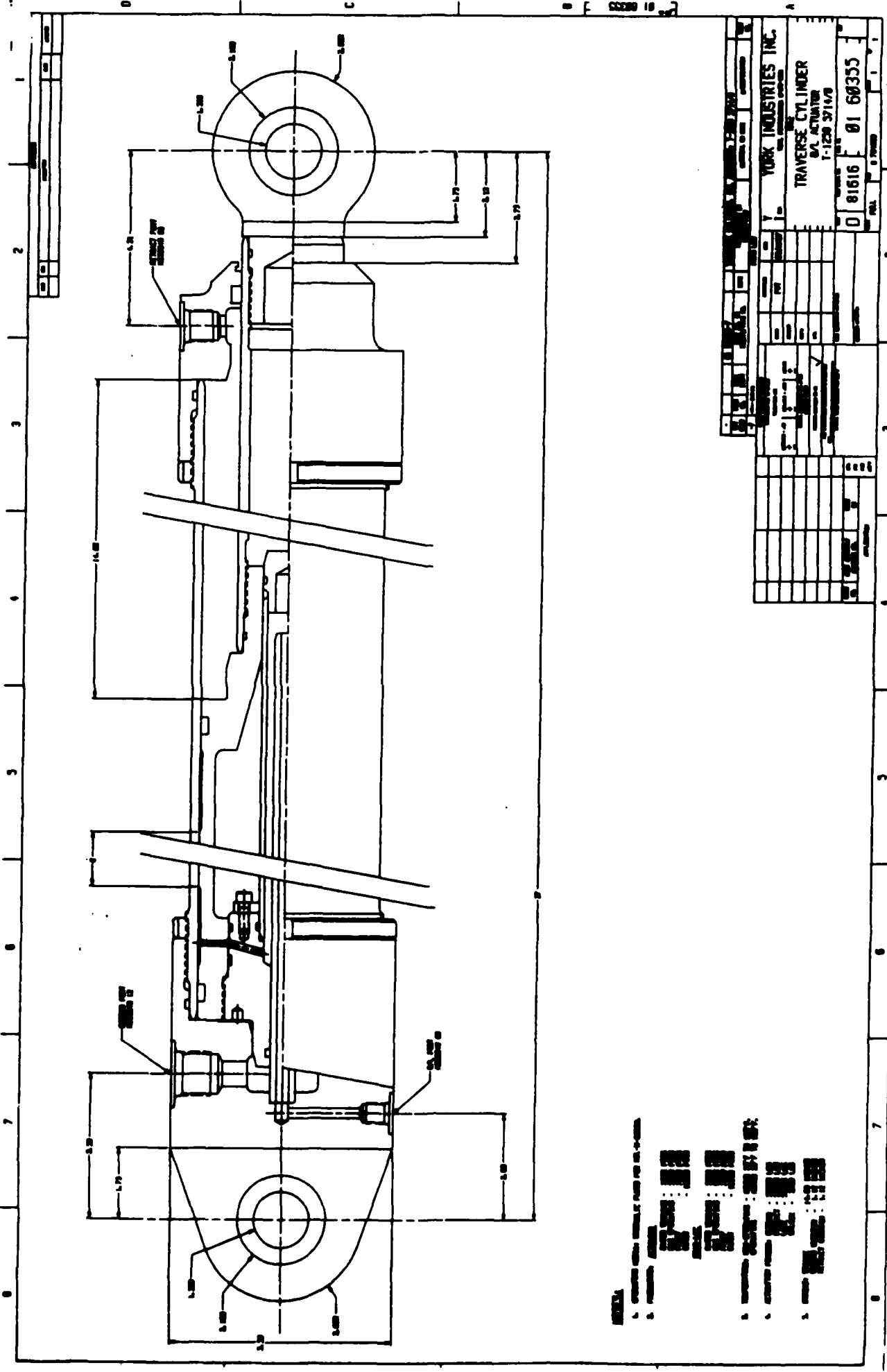
DESCRIPTION: TRAVERSE ACTUATOR (Obsolete)

1	2	3	4	5	6	7	8	9	10



1. 1-1/2" DIA. BORE
 2. 1-1/2" DIA. BORE
 3. 1-1/2" DIA. BORE
 4. 1-1/2" DIA. BORE
 5. 1-1/2" DIA. BORE
 6. 1-1/2" DIA. BORE
 7. 1-1/2" DIA. BORE
 8. 1-1/2" DIA. BORE
 9. 1-1/2" DIA. BORE
 10. 1-1/2" DIA. BORE

YORK INDUSTRIES INC.	
TRAVERSE CYLINDER	
DA. ACTUATOR	
1-120 37140	
0 81616	01 60355



YORK INDUSTRIES INC.	
TRAVERSE CYLINDER	
VAL ACTUATOR	
1-120 3714/0	
0 81616	01 60355
D 81616 01 60355	

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98. 1.75

99. 1.75

100. 1.75

DESCRIPTION: WALKING BEAM ACTUATOR - LH FRONT**STATUS - PER YORK:**

The concept drawing on this component had been completed and the assembly drawing was being revised to incorporate 2 inches of free travel in the transit mode. Several approaches to obtain free travel were being evaluated which would have been added to the assembly drawing when complete. The design provisions for free travel were being evaluated on the rear actuators and would have been added to these actuators when complete.

An extended stroke pin lock was incorporated into the actuator. This lock is actuated by hydraulic pressure and provides a flag of lock/unlock status.

The assembly drawing was being revised to mount the FMC specified control valve directly on the actuator.

This unit, as revised, exceeds its weight budget by 20% and required further design effort directed at weight reduction.

STATUS - PER FMC:

See C/270 (Dynamic Analysis of Walking Beam Actuators) for description of options under evaluation to solve road-input-induced fluid flow problem.

Note also the 3500 PSI safety fuze (item 21), to further protect LIHD hardware against potential damage due to unanticipated road-input bump velocities beyond design limits, pending acquisition of actual road-inputs data.

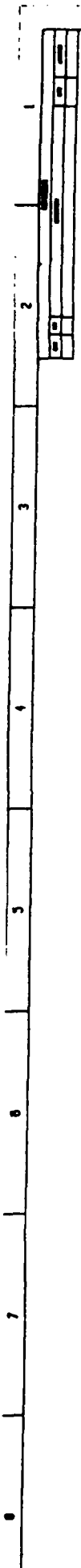
AUTHOR: Jeff Ireland/Bart Anderson

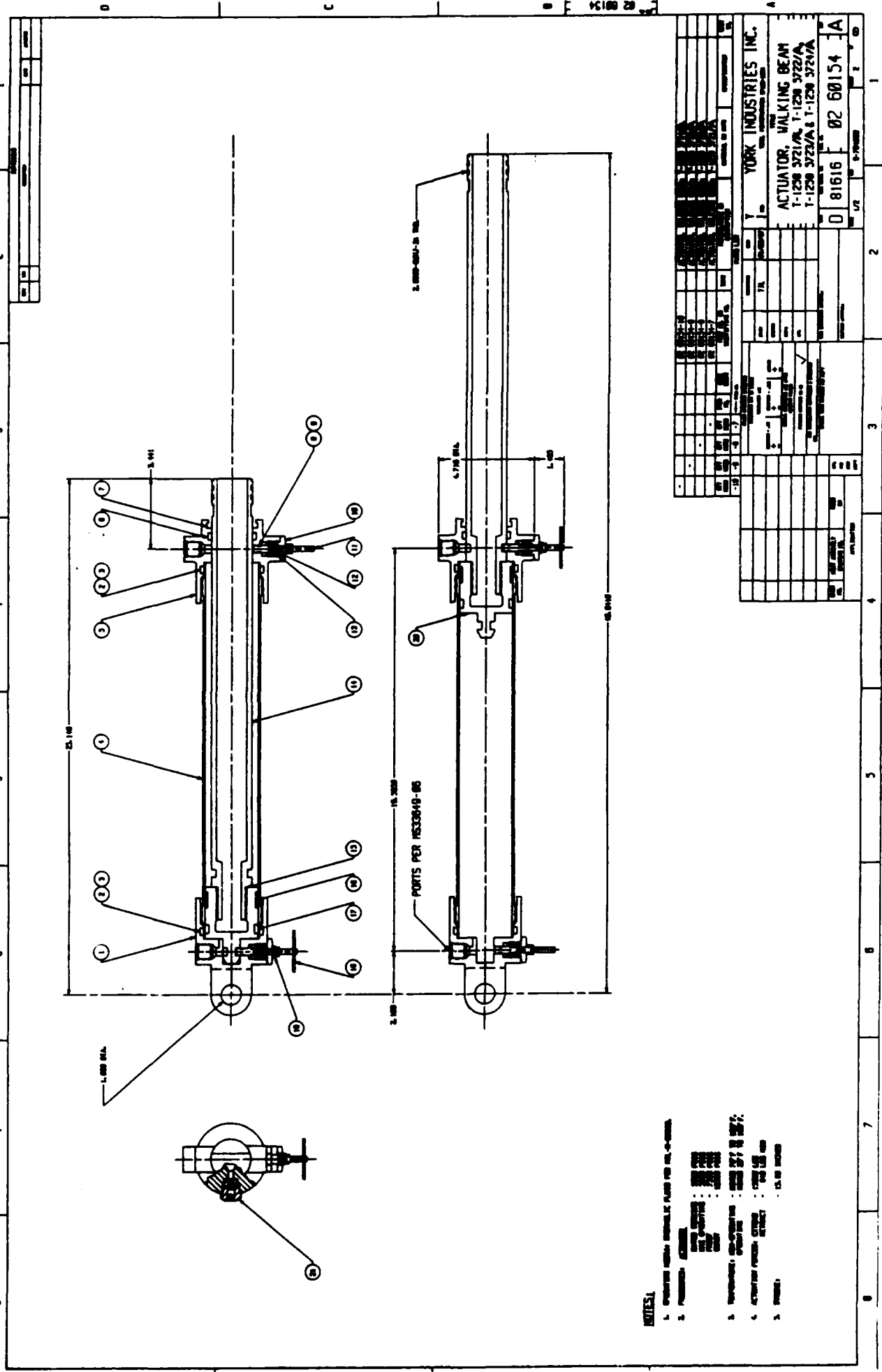
02 08154

E/261

DESCRIPTION: WALKING BEAM ACTUATOR - LH FRONT (Obsolete)

82 68154

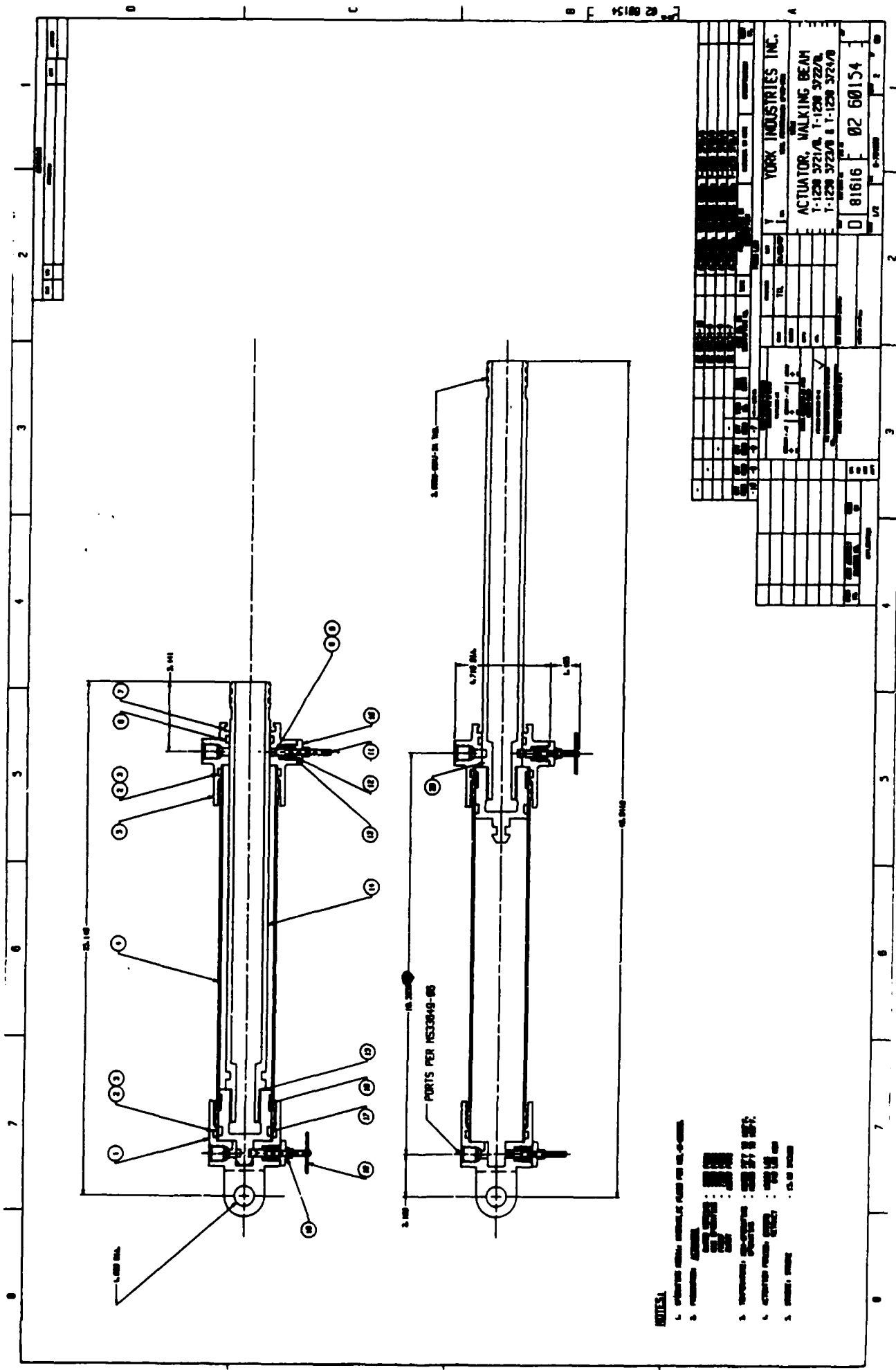
[illegible]



NOTES:

1. OPERATOR SHALL INSTALL PLUG PER MS-33040
2. PRELIMINARY
3. DIMENSIONS: 0.0001 IN. TYP.
4. ACTUATOR PORTS: 0.750 IN. DIA.
5. WEIGHT: 15.00 LBS.

YORK INDUSTRIES INC.	
ACTUATOR, WALKING BEAM	
1-1238 3721/A, 1-1238 3722/A	
1-1238 3723/A, 1-1238 3724/A	
D 81616	02 60154 A



- NOTES:
1. OPERATOR: HSC040-00
 2. OPERATOR: HSC040-00
 3. OPERATOR: HSC040-00
 4. OPERATOR: HSC040-00
 5. OPERATOR: HSC040-00

YORK INDUSTRIES INC.	
ACTUATOR, WALKING BEAM	
1-1230 3721/0 1-1230 3722/0	
1-1230 3723/0 1-1230 3724/0	
Q 81616	02 60154

DESCRIPTION: WALKING BEAM ACTUATOR - LH REAR

STATUS - PER YORK:

The concept drawing on this component had been completed and the assembly drawing was being revised to incorporate 2 inches of free travel in the transit mode. Several approaches to obtain free travel were being evaluated which would have been added to the assembly drawing when complete.

The extended stroke pin lock was also incorporated into the actuator.

The assembly drawing was being revised to mount the FMC specified control valve directly on the actuator.

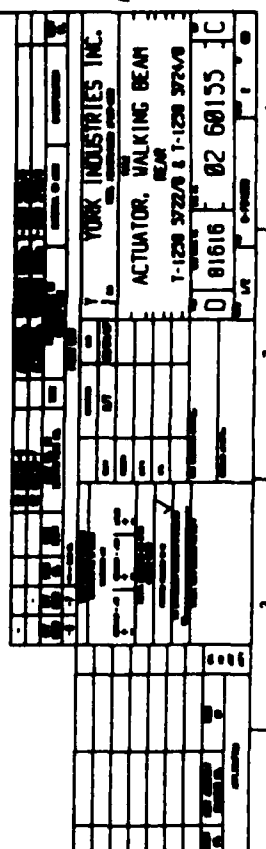
This unit, as revised, exceeds its weight budget by 20% and required further design effort directed at weight reduction.

STATUS - PER FMC:

See E/260

AUTHOR: Jeff Ireland/Bart Anderson

02 60153



7F CC1009 20 91910

[illegible]

DESCRIPTION: WALKING BEAM ACTUATOR - RH FRONT

STATUS - See E/260

DESCRIPTION: WALKING BEAM ACTUATOR - RH REAR

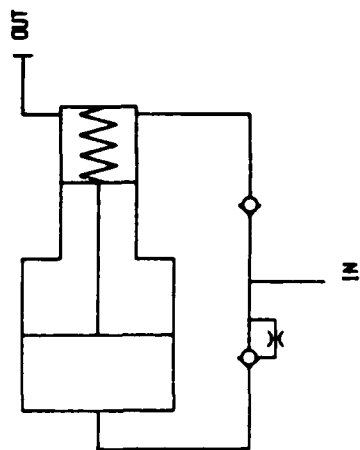
STATUS - See E/270

DESCRIPTION: BEAR-LOC INTENSIFIER ASSEMBLY

PMC COMMENT:

Operation of the Bear-Loc at an intensified pressure facilitates a smaller and lighter Bear-Loc for the same holding force. Since the intensifier is mounted on the actuator it serves, and hardlined by York, it's presence is somewhat transparent to the hydraulic system.

AUTHOR: Jeff Ireland/Bart Anderson

[illegible][illegible]

DESCRIPTION: ACCUMULATOR VOLUME (PISTON POSITION) INDICATOR ASSEMBLY

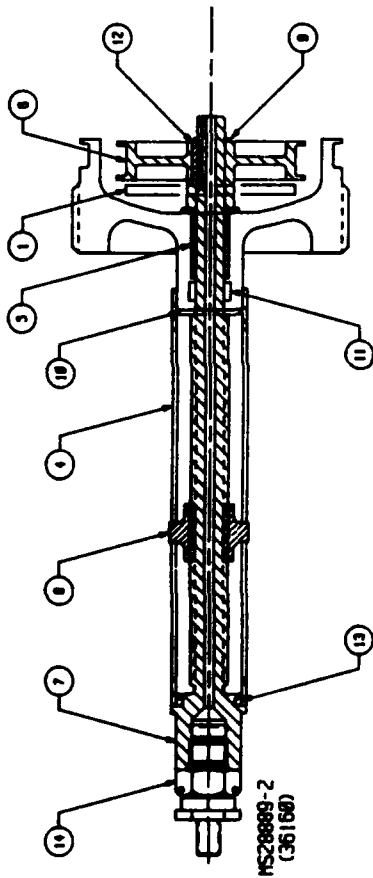
FMC COMMENT:

This method for indicating accumulator oil volume was chosen over the traditional indicator rod for weight and space reasons.

One end of a cable is attached to the piston while the other end is reeled. The reel is (torsionally) spring-loaded. A stud is attached to reel and turns with it. A nut is threaded onto the stud, but not allowed to rotate with the stud. Thus, piston movement turns the reel, which rotates the stud, and displaces the nut. The nut travel is about 4" and thus serves as a volume indicator.

An indicator similar to this has been flight certified and is in use on one of the F-1X fighter aircraft (I can't remember which one).

AUTHOR: Jeff Ireland/Bart Anderson



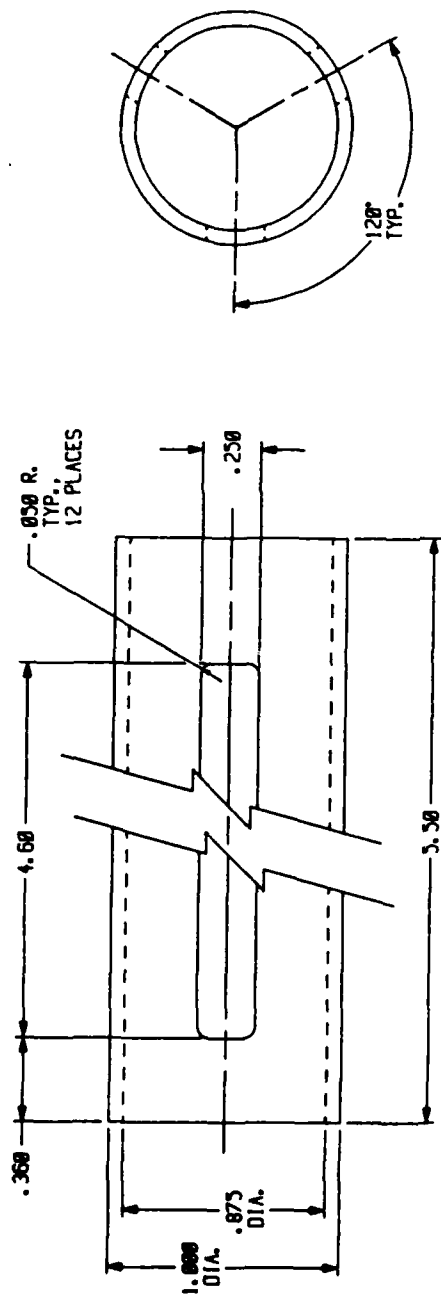
NOTES:



QTY	UNIT	DESCRIPTION	REF. DES.	QTY	UNIT	DESCRIPTION	REF. DES.
1	VALVE	VALVE, GAS	08 40577-1	1	INDICATOR	INDICATOR	08 40577-2
1	RETAINING RING	RETAINING RING	08 40577-3	1	PIVOT	PIVOT	08 40577-4
1	SEAL RING	SEAL RING	08 40577-5	1	SPRING	SPRING	08 40577-6
1	WASHER, THIN	WASHER, THIN	08 40577-7	1	POSITION INDICATOR ASSEMBLY	POSITION INDICATOR ASSEMBLY	08 40577-8
1	KEY	KEY	08 40577-9	1	POSITION INDICATOR ASSEMBLY	POSITION INDICATOR ASSEMBLY	08 40577-10
1	INDICATOR	INDICATOR	08 40577-11	1	POSITION INDICATOR ASSEMBLY	POSITION INDICATOR ASSEMBLY	08 40577-12
1	PIVOT, DRIVE	PIVOT, DRIVE	08 40577-13	1	POSITION INDICATOR ASSEMBLY	POSITION INDICATOR ASSEMBLY	08 40577-14
1	WHEEL	WHEEL	08 40577-15	1	POSITION INDICATOR ASSEMBLY	POSITION INDICATOR ASSEMBLY	08 40577-16
1	SPRING	SPRING	08 40577-17	1	POSITION INDICATOR ASSEMBLY	POSITION INDICATOR ASSEMBLY	08 40577-18
1	PIVOT	PIVOT	08 40577-19	1	POSITION INDICATOR ASSEMBLY	POSITION INDICATOR ASSEMBLY	08 40577-20
1	WASHER, THIN	WASHER, THIN	08 40577-21	1	POSITION INDICATOR ASSEMBLY	POSITION INDICATOR ASSEMBLY	08 40577-22
1	SEAL RING	SEAL RING	08 40577-23	1	POSITION INDICATOR ASSEMBLY	POSITION INDICATOR ASSEMBLY	08 40577-24
1	RETAINING RING	RETAINING RING	08 40577-25	1	POSITION INDICATOR ASSEMBLY	POSITION INDICATOR ASSEMBLY	08 40577-26
1	VALVE	VALVE	08 40577-27	1	POSITION INDICATOR ASSEMBLY	POSITION INDICATOR ASSEMBLY	08 40577-28

YORK INDUSTRIES INC.	
POSITION INDICATOR ASSEMBLY	
C 81616	08 40577
FILL	

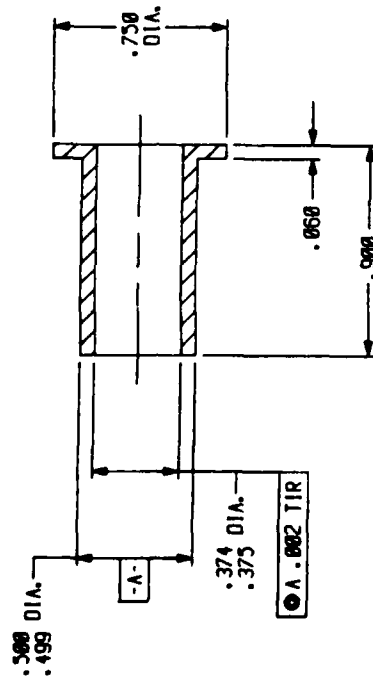
REVISIONS		
LTR	DESCRIPTION	DATE



NOTES:

- MATERIAL: ALUMINUM, 2024-T3 PER
- REMOVE ALL BURRS AND BREAK SHARP EDGES .005/.010.

QTY -7	ITEM NO.	CODE IDENT.	PART NO. OR IDENTIFYING NO.	HOUSING, INDICATOR NOMENCLATURE OR DESCRIPTION	MATERIAL OR NOTE	SPECIFICATION	UNIT WT.																				
<table border="1"> <tr> <td colspan="2">YORK INDUSTRIES INC.</td> <td>DATE</td> <td>81-14-87</td> </tr> <tr> <td colspan="2">YORK, PENNSYLVANIA 17402-1801</td> <td>DESIGNED BY</td> <td>GAK</td> </tr> <tr> <td colspan="2">HOUSING, INDICATOR</td> <td>CHECKED BY</td> <td> </td> </tr> <tr> <td colspan="2">SIZE</td> <td>8</td> <td>81616</td> </tr> <tr> <td colspan="2">SCALE</td> <td>2/1</td> <td>8-784888</td> </tr> </table>								YORK INDUSTRIES INC.		DATE	81-14-87	YORK, PENNSYLVANIA 17402-1801		DESIGNED BY	GAK	HOUSING, INDICATOR		CHECKED BY		SIZE		8	81616	SCALE		2/1	8-784888
YORK INDUSTRIES INC.		DATE	81-14-87																								
YORK, PENNSYLVANIA 17402-1801		DESIGNED BY	GAK																								
HOUSING, INDICATOR		CHECKED BY																									
SIZE		8	81616																								
SCALE		2/1	8-784888																								
DASH NO.		NEXT ASSEMBLY DRAWING NO.		APPLICATION		QTY PER ASST																					
-7		08 40577		USED ON		PER NEXT																					



NOTES:

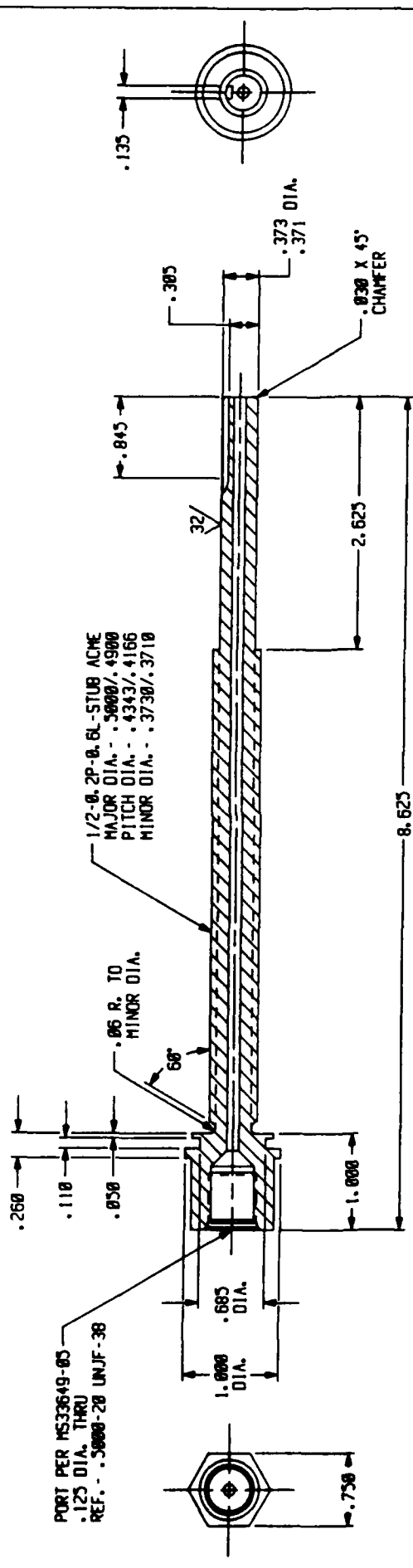
1 MATERIAL:

2. REMOVE ALL BURRS AND BREAK SHARP EDGES .005/.010.

QTY	ITEM	CODE	PART NO. OR IDENTIFYING NO.	DESCRIPTION	DATE	SIGNATURE	UNIT
-7			08 40573-7	BUSHING	01-14-67	GAK	VT.
<p>YORK INDUSTRIES INC. YORK, PENNSYLVANIA 17402-1001</p>							
<p>BUSHING</p>							
<p>SIZE 8 81616 08 40573</p>							
<p>SCALE 2/1 8-704000</p>							

[illegible]

REVISIONS		
LTR	DESCRIPTION	DATE



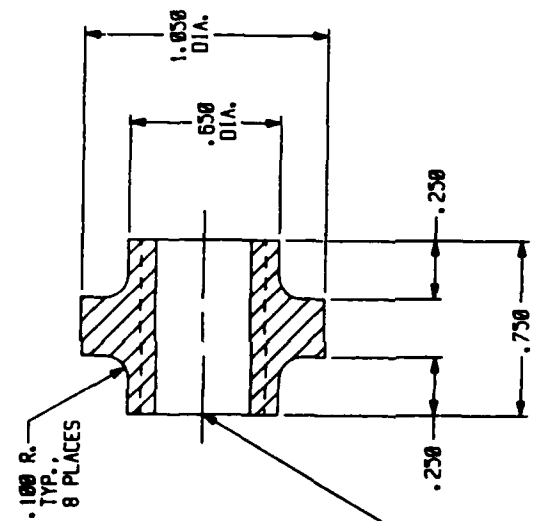
NOTES:

1. MATERIAL: CRES STEEL, 17-4 PH PER AMS 3643/2303.
2. REMOVE ALL BURRS AND BREAK SHARP EDGES .005/.010.
3. MAGNETIC PARTICLE INSPECT PER MIL-1-XX.
4. PASSIVATE PER QQ-P-35, TYPE II.

QTY	ITEM	CODE	SHAFT, DRIVE	UNIT
REQD	NO.	IDENT.	DESCRIPTION	WT.
-7				

YORK INDUSTRIES INC.		YORK, PENNSYLVANIA 17402-1001	
SHAFT, DRIVE		Y	
SIZE		8	
SCALE		FULL	
DATE		8-78/000	
DRAWING NO.		08 40575	
REV.		1	

REVISIONS		
LTR	DESCRIPTION	DATE



1/2-8-28-8. BL-STUB ACME
 MAJOR DIA. - .5200/.5377
 PITCH DIA. - .4400/.4577
 MINOR DIA. - .4100/.4200

NOTES:

1. MATERIAL: NYLON PER LP410.
2. REMOVE ALL BURRS AND BREAK SHARP EDGES .005/-.010.

QTY		ITEM	CODE	08 40576-7	INDICATOR	MATERIAL OR NOTE		SPECIFICATION	UNIT
REQD		NL	IDENT.	PART NL OR IDENTIFYING NO.	INDICATOR DESCRIPTION	Y		YORK INDUSTRIES INC.	WT.
-7								YORK, PENNSYLVANIA 17402-1001	
				RELAS DIMENSIONS SPECIFIED DIMENSIONS ARE IN INCHES DECIMALS - 1/16 (0.0625) - 1/8 (0.125) - 1/4 (0.250) - 3/8 (0.375) - 1/2 (0.500) - 3/4 (0.750) - 1 (1.000) - 1 1/4 (1.125) - 1 1/2 (1.500) - 2 (2.000) - 2 1/2 (2.500) - 3 (3.000) - 3 1/2 (3.500) - 4 (4.000) - 4 1/2 (4.500) - 5 (5.000) - 5 1/2 (5.500) - 6 (6.000) - 6 1/2 (6.500) - 7 (7.000) - 7 1/2 (7.500) - 8 (8.000) - 8 1/2 (8.500) - 9 (9.000) - 9 1/2 (9.500) - 10 (10.000)		DATE			
				+.020 +.010 +.1° PER DIMENSIONS OF PARTS LISTED THEREIN		GAK		01-12-87	
				FINISHED SURFACES TO BE 125/		YORK INDUSTRIES APPROVAL			
DASH NL		08 40577		QTY		PER		SIZE	
NEXT ASSEMBLY		DRAWING NL		USED		ON		B	08 40576
APPLICATION				NEXT		ASSY		DATE	8-784000
				2/1		8-784000		1	1

END

10-87

DTIC